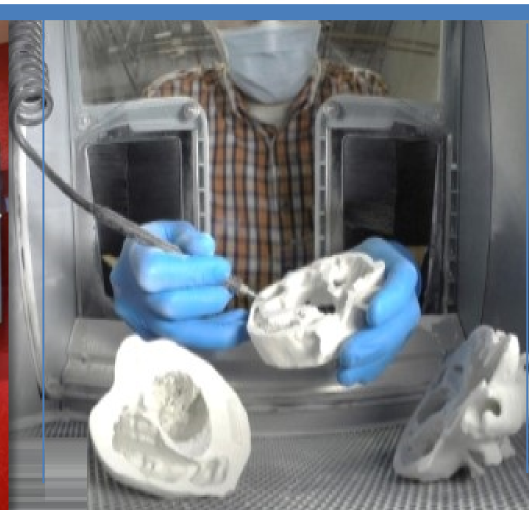
HCESC

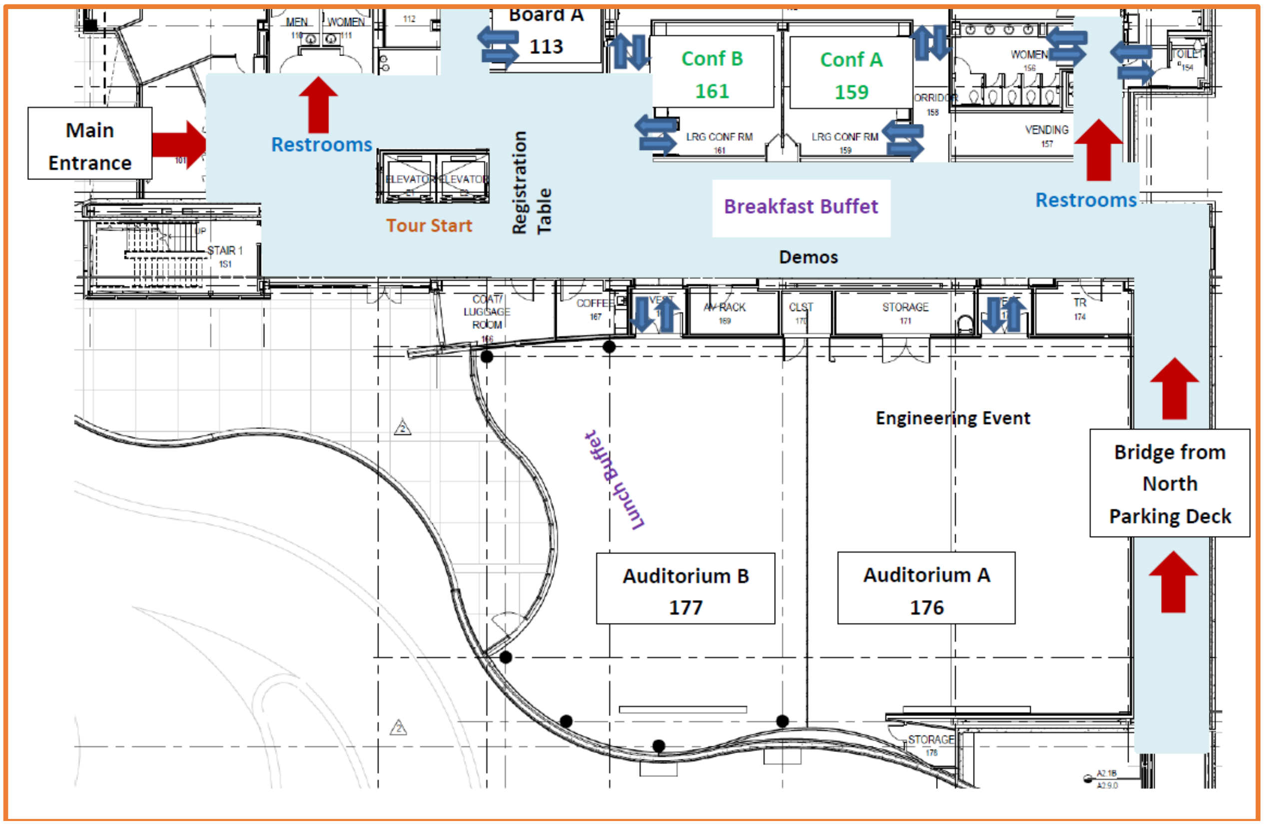


3rd Health Care Engineering Systems Symposium

September 9, 2016

Jump Trading Simulation & Education Center
OSF Saint Francis Medical Center
Peoria, IL

SYMPOSIUM INFORMATION



Restrooms are located outside of the Auditorium and near the parking deck bridge (in blue).
Posters, Lunch and Reception will be in Auditorium B (in purple).
Breakfast Buffet will be in the pre-function area (in purple).
Jump tours will meet in front of the elevators (in orange).
Internet Access is free, please connect to the GUEST network for access.

The ARCHES Symposium Organizing Committee

Dr. John Vozenilek, Dr. T. Kesh Kesavadas, Dr. Tony Michalos, and Ms. Jessica Svendsen

The organizing committee would like to thank Michelle L. Osborne, Don Halpin, Bre Rogy, Erika Wilkerson, Chase Salazar, Betsy Holzwarth and Dr. Ann Willemsen-Dunlap for aiding the preparation of the symposium and Jump Simulation for hosting the event.

For more information about the ARCHES program please visit:

Health Care Engineering Systems Center: http://healtheng.illinois.edu/
Jump Simulation & Education Center: http://www.jumpsimulation.or

Fall 2016 Request for Proposals

The Jump Applied Research for Community Health through Engineering and Simulation [Jump ARCHES] Endowment offers this Request for Proposals to members of faculty of the University of Illinois College of Engineering at Urbana-Champaign, members of faculty of the University of Illinois College of Medicine at Peoria, and/or OSF Healthcare System clinicians. The goal of this competitive grant is to improve healthcare quality and patient safety through the combined efforts of engineers and clinicians.

➢ Important Dates

September 12, 2016	Fall Request for Proposals Opens
October 12, 2016	Deadline for Submission at 5pm CST
December, 2016	Announcement of Winners

NOTE: A link to this online submission mechanism, which will closely follow the NIH R21 mechanism format, will be available after September 12, 2016 on:

http://healtheng.illinois.edu/funding/ and on

http://jumpsimulation.org/innovation/ARCHES/index.html

Please visit the above websites to understand how to prepare a responsive application, use of funds and the review process.

T. Kesh Kesavadas, PhD

Director
Health Care Engineering Systems Center

University of Illinois at Urbana-Champaign

http://healtheng.illinois.edu/

John Vozenilek, MD

Vice President and Chief Medical Officer
Jump Trading Simulation and Education Center

OSF Healthcare System

http://jumpsimulation.org

3rd Health Care Engineering Systems Symposium

Jump Trading Simulation and Education Center
September 9, 2016

8:30 – 9:00 AM	**Arrival of the Participants** *Breakfast and Registration*	
9:00 – 10:30 AM	**Opening Remarks**	
	Sister Diane Marie, O.S.F.	Opening Prayer & Remarks
	John Vozenilek, MD T. Kesh Kesavadas, PhD	ARCHES: Disrupting Clinical Education Through Innovation
	Peter Schiffer, PhD	Opening Remarks
	Jennifer Bernhard, PhD	Opening Remarks
	Sara Rusch, MD	Opening Remarks
	Michelle Conger	Innovators for Life: Our Vision for Innovation Across the OSF Ministry
	Lori Wiegand, DNP	Innovation in Patient Care: What it Means to the Frontline Nurse Today & Tomorrow
	Stephen Hippler, MD	What Innovation Looks Like in Quality & Safety Across the OSF Ministry
	Jeff Tillery, MD	Collaboration, Innovation and Functional Transformation for Better Patient Care
10:30 – 10:45 AM	**Break**	
10:45 – 11:00 AM	**Key Updates** The ARCHES Partnership and Intellectual Property *Svetlana Sowers, PhD*	
	Update on the Carle-Illinois College of Medicine *Rashid Bashir, PhD*	

11:00 – 11:20 AM **Scientific Talks** **Klara Nahrstedt, Moderator**

Teaching Neurosurgery Residents New Surgical Techniques: A Pilot Study
Anthony Avellino

Graphene-Integrated Biomedical Devices
SungWoo Nam

Synthetic Tethered Spinal Cord Model for Neurosurgical Residents Training
Julian Lin

11:20 – 11:30 AM **Announcement of ARCHES Winners**
John Vozenilek, MD and T. Kesh Kesavadas, PhD

11:30 AM – 1:00 PM **Lunch and Jump Tours** **Sister M Mikela, F.S.G.M., Prayer**

1:00 – 2:00 PM **Scientific Talks** **William Bond, Moderator**

A Hardware-in-the-loop Simulator for Safety Training in Robotic Surgery
T. Kesh Kesavadas

Next Generation 3D Printed Infant Hearts for Pre-Operative Planning
Rashid Bashir

Toward Implementation of 3D Modeling in a Health System
Matthew Bramlet

An Integrated Approach to Healthcare Delivery
Irfan Ahmad

Development & Eval of a Passive Hyd Sim for Elbow Spasticity Replication
Yinan Pei

Human and Data Analytics Interactions in Readmission Risk Assessment
Deborah Thurston

Camera-Based System for Assessing Fall Risk and Exercise Compliance
Rama Ratnam

Enterprise Terminology Platform IMO 2.0
Frank Naeymi-Rad

Multimodal Cardiac Phantom for Imaging-based Modeling, Sim., & Stand.
Wawrzyniec Dobrucki

Visualization and Modeling of Musculoskeletal Tissues
Mariana Kersh

2:00 – 2:15 PM **Break**

2:15 – 3:15 PM **Scientific Talks** **Rashid Bashir, Moderator**

Altered PFC Activation During Locomotion in Older Adults with M.S.
Manuel Hernandez

Automating Urine Output Measurements to Improve Acute Kidney Injury Diagnosis and Management
Jay Joshi

Results & Next Steps for 3D Avatar Models Applications in Healthcare
Ann Willemsen-Dunlap and Don Halpin

Providers Like Me
Mike DeCaro

Epidermal Wearable Biomedical Devices: A Human Centered Design Study
Michael James Hansen

Training Isometric Force Matching Tasks in Classical Ballet Postures in Children With Dystonic Cerebral Palsy
Citlali López-Ortiz

Population Health Mgt. with Passive Mobile Monitors Using Smartphones
Bruce Schatz

Deep Analytics Enabling Precision Medicine
Arjun Prasanna Athreya

Intelligent Problem List Reconciliation
Steven Rube

Activity Trackers for Patients
Kimberly Hasselbacher

3:15 – 3:30 PM **Break**

3:30 – 4:00 PM **Posters** **Auditorium B**

4:00 – 5:00 PM **Reception** **Auditorium B**

Demonstrations Pre-Function Space

Development of a Robotic Forearm to Simulate Abnormal Muscle Tone Due to Brain Lesions
ARCHES Award Winner 2014
Presented by: Yinan Pei

Care Innovations® Health Harmony Home Monitoring System
Presented by: Jessica Svendsen, Mayank Taneja

Simulating Nature, Enhancing Health: Exploring Therapeutic Apps of Natural Environments in VR
Presented by: Katie Mimnaugh and Matthew Browning

Improving 3D Avatar Models for Applications for Health Care
ARCHES Award Winner 2014 & 2015
Presented by: Kevin Gu

Robot-Assisted Home-Based Adaptive Rehabilitation System
Presented by: Shrey Pareek

Simulation Training to Identify Fall Risk in the Home Environment
ARCHES Award Winner 2015
Presented by: Rama Ratnam

Posters **Auditorium B**

Dynamic Myocardial Phantom for Calibration of Multimodal Imaging and Modeling Methods
Hiba Shahid

Simulating Nature, Enhancing Health: Exploring Therapeutic Applications of Natural Environments in Virtual Reality
Katherine Mimnaugh

Lifelike Training Device for Simulated Radial Artery Cannulation
Mark Doose

New Medical Device that Identifies Tear Film Biomarker to Evaluate Corneal Integrity
Matthew Bowman
Gina Taylor

Non-Invasive Point-of-Care Diagnostic for Detection of Salivary Cortisol Concentration Using a Low Cost Electrical Biosensor Chip
Muhammad S. Khan

Development of Disposable Ocular Biosensor for Real Time Detection of Ascorbic Acid in Tear Film and Aqueous Humor
Muhammad S. Khan

Simulation Training for Mechanical Circulatory Support using Extra-Corporeal Membrane Oxygenation (ECMO) in Adult Patients
Pramod Chembrammel

Positive User Experience in Assistive Devices for People with Disabilities: A Case Study of a Personal Voice Amplifier
Rachel Heaton

Prototyping a Quasi Four Dimensional Drug-eluting Stent for Personalized Management of Arterial Plaques
Santosh K. Misra

Robust Interactive Visualization Platform for the Screening and Monitoring of Behavior
Wai-Tat Fu

Audio-Visual Emotive Avatar with Application to Doctor-Patient Interaction
Kevin Gu

A Hardware-in-the-loop Simulator for Safety Training in Robotic Surgery
Xiao Li

Opening Prayer & Remarks

Sister Diane Marie McGrew, O.S.F.
President
OSF HealthCare System

Sister Diane Marie McGrew, O.S.F, Board Member, President, and Treasurer, has been a member of the Congregation since 1988. Sister Diane Marie was appointed President of OSF Healthcare System in 2006. She was elected to the Governing Board of the Congregation and to the office of Treasurer for the Congregation and for the Corporation in 2000. She has served as a Board member of OSF Healthcare System since 1998. She served as a Board member of OSF Health Plans from 1999 until its sale in 2008. She was appointed to the Board of OSF Healthcare Foundation in 2001 and has served on the Board of OSF Saint Francis Inc since 2003. Sister has also been a member of the Finance Council of the Catholic Diocese of Peoria since 1995. From 1990 to 2000, Sister served as a Corporate Accountant at the Corporate Office. Sister holds a Bachelor of Business degree in accounting from Western Illinois University, Macomb, Illinois. Sister is a member of the National Association of Treasurers of Religious Institutes and the American College of Healthcare Executives.

Lunch Prayer

Sister M. Mikela Meidl, F.S.G.M
Executive Vice President & Chief Ministry Officer
OSF HealthCare System

Sister M. Mikela, F.S.G.M received her Bachelor's Degree in Nursing in 1993 from the Franciscan University of Steubenville (Steubenville, OH). She went on to get her MBA with Healthcare Management from Regis University (Denver, CO) in 2009. Before coming to Ministry Services Administration, Sr. M. Mikela held the position of CEO & President of Saint Anthony's Health Center in Alton, Illinois. She was also Chair of Saint Anthony's Health Center and President of their Foundation. Some of her professional background includes: DON and later Administrator of a 114 bed Skilled Nursing Facility run by her Community in St. Louis, MO, During her years as V.P at Saint Anthony's she was executive leaders over such areas as: nursing, therapies, pharmacy, quality, patient experience, risk management, HR, Care Management (Social Work and Case Management), Cardiology and CVL, Compliance, Ethics, Mission Integration and Governance.

Saint Anthony's Health Center merged with OSF Healthcare System on November 1, 2014 to become OSF Saint Anthony Health Center. At that time, Sister M Mikela was appointed to the OSF Healthcare System Board of Directors. She took office at Ministry Services Administration on November 17, 2014 taking on the role of Executive Vice President.

ARCHES: Disrupting Clinical Education Through Innovation

John Vozenilek, MD, FACEP
Vice President & Chief Medical Officer for Simulation
Jump Simulation and Education Center, OSF HealthCare
Duane and Mary Cullinan Professor in Simulation Outcomes
University of Illinois College of Medicine at Peoria
College of Engineering, University of Illinois at Urbana-Champaign

Dr. Vozenilek is the Director of Simulation and Chief Medical Officer of the Jump Trading Simulation and Education Center where he provides central coordination and oversight for OSF Healthcare's undergraduate, graduate, interdisciplinary, and continuing medical education programs. Under his direction, the OSF Healthcare and the University Of Illinois College Of Medicine at Peoria have created additional organizational capabilities and infrastructure, building resources for educators who wish to use additional innovative learning technologies for teaching and assessment. As the Duane and Mary Cullinan Professor in Simulation Outcomes Dr. Vozenilek is actively involved in the academic programs across traditional departmental boundaries and in clinical practice at OSF Healthcare. In addition to his role in simulation, Dr. Vozenilek teaches master's degree candidates in the fields of simulation, healthcare quality and safety, and is formally appointed in the UI Urbana-Champaign College of Engineering to teach biodesign.

ARCHES: Disrupting Clinical Education Through Innovation

Thenkurussi "Kesh" Kesavadas, PhD
Professor of Industrial and Enterprise Systems Engineering
Director, Health Care Engineering Systems Center
University of Illinois at Urbana-Champaign

Dr. Kesavadas is the Director of Health Care Engineering Systems Center at the University of Illinois at Urbana-Champaign. Before coming to Illinois, Kesavadas was a professor in the Department of Mechanical and Aerospace Engineering at the University at Buffalo (NY), where he founded the University at Buffalo Virtual Reality Laboratory. He received his doctoral degree from the Pennsylvania State University in 1995. Kesavadas has been in the forefront of Virtual Reality and its application to medicine since 1993, when this field was still in its infancy. In 2004, Dr. Kesavadas was honored as the "Inventor of the Year" Western New York. He has also won numerous awards including SUNY Chancellor's award for Innovation in 2004 and UB Visionary of the year award in 2010. He developed the world's first stand-alone virtual reality Robotic Surgical Simulator RoSS and also co-founded two start-up companies. His own research interests are in the areas of medical robotics and simulation, virtual reality in design, haptics and human-computer interaction. Kesavadas is a Fellow of American Society of Mechanical Engineering and a member of IEEE.

As HCES Center director, Kesavadas will lead the development of the new Center and its research program. He also serves as "Engineer in Chief" of the Jump ARCHES collaborative partnership between the College of Engineering at Illinois and health care providers at OSF HealthCare and at the University of Illinois' College of Medicine at Peoria.

Opening Remarks

Peter Schiffer, PhD
Professor of Physics
Vice Chancellor of Research
University of Illinois at Urbana-Champaign

Dr. Schiffer is the Vice Chancellor for Research at the University of Illinois at Urbana-Champaign, where he has leadership responsibility for campus-wide interdisciplinary research institutes, promotes new research initiatives, and oversees the administrative and business processes that ensure the productive, safe, and ethical conduct of research at Illinois. Before joining Illinois, Dr. Schiffer served in a number of administrative, faculty, and research roles at Pennsylvania State University. Prior to that, he was on the faculty at the University of Notre Dame, and performed postdoctoral work at AT&T Bell Laboratories.

His personal research focuses on artificial spin ice, geometrically frustrated magnets and other magnetic materials. He has co-authored more than 175 papers, and is the recipient of a Career Award from the National Science Foundation, a Presidential Early Career Award for Scientists and Engineers from the Army Research Office, an Alfred P. Sloan Research Fellowship recipient, and he received the Faculty Scholar Medal in the Physical Sciences and the Joel and Ruth Spira Award for Teaching Excellence from Penn State. He is also a Fellow of the American Physical Society. Dr. Schiffer his B.S. from Yale University in 1988 and his Ph.D. from Stanford University in 1993.

Opening Remarks

Jennifer Bernhard, PhD
Professor of Electrical and Computer Engineering
Associate Dean for Research, College of Engineering
University of Illinois at Urbana-Champaign

Dr. Bernhard is the Associate Dean for Research at the College of Engineering. Her research addresses applications-oriented electromagnetic problems with an emphasis on theoretical analysis and experimental investigation. Her research group focuses on two areas: Electromagnetics for Wireless Communication and Reconfigurable Active and Passive Antennas.

In these research areas, Prof. Bernhard's group investigates the effects of packaging on antenna performance and uses these results to develop design-oriented models for internal antennas, embedded antennas, and diversity schemes. The research also creates synthesis approaches for internal portable antenna systems that produce desired performance while reducing user exposure and battery usage. Her research implements reconfigurability in antenna structures to provide flexibility in operating frequency, bandwidth, and radiation pattern performance. The research group is supported by a specialized fabrication facility, a new anechoic chamber, Agilent vector network analyzers, a unique bit error rate measurement system for antennas, and opportunities for collaborations with the UIUC Center for Computational Electromagnetics.

Opening Remarks

Sara L. Rusch, MD, MACP
Dean, University of IL College of Medicine at Peoria

Dr. Rusch was appointed Regional Dean of the University Of Illinois College Of Medicine at Peoria in January 2008, becoming the college's seventh regional dean since it was established in 1970.

Dr. Rusch practiced general internal medicine in a private practice group from 1981-2001 and as a hospitalist from 2001-2008. She served as the Chair of the Department of Medicine at the University of Illinois College of Medicine at Peoria (UICOMP) from 1995-2008, and held the same position for OSF Saint Francis Medical Center from 1993-2008. She also was the residency program director for the Department of Internal Medicine from 1995-1999 and from 2005-2006.

She graduated from the University of Wisconsin in 1974 with a BA degree in Molecular Biology and received her medical degree from the University of Wisconsin in 1978.

Since becoming Regional Dean, Dr. Rusch has led multiple efforts to improve UICOMP. This includes facility improvements, advancing simulation training, expanding research, and building the graduate medical education programs. She oversaw the $13 million expansion of the Cancer Research Center; construction of small-group active learning spaces to advance medical student education; and transformation of the Donald E. Rager, MD Clinical Skill Laboratory. Under her leadership, UICOMP in partnership with OSF HealthCare helped in the development, construction and opening of the Jump Trading Simulation & Education Center, a state-of-the-art virtual hospital and medical simulation facility.

Research and educational activities also have grown, including establishment of the Center for Outcomes Research, a residency program in psychiatry with UnityPoint Health – Methodist, fellowship training programs in cardiovascular disease and gastroenterology, and formal accreditation of a fellowship program in vascular neurology, or stroke.

Dr. Rusch served as Governor for the Illinois downstate chapter of the largest medical specialty organization in the U.S. – the American College of Physicians – from 2005-2009. In April of 2010, Dr. Rusch was elected to ACP Mastership. She also has been recognized as an educator and mentor of young physicians, an academic leader and a skilled clinician, receiving the Athena Award from the Peoria Area Chamber of Commerce in 2011, UIC Woman of the Year in 2011 and Mother M. Frances Krasse Healthcare Professions Leader award from the YWCA in 2012.

Innovation for Life: Our Vision for Innovation Across the OSF Ministry

Michelle Conger
Senior Vice President and Chief Strategy Officer
OSF Healthcare System

Ms. Conger is Senior Vice President and Chief Strategy Officer for OSF Healthcare System. She has over 20 years of healthcare leadership experience and has been in her current position since 2010. In this role, shehas the responsibility for partnering with the CEO, board and leadership in the ongoing generation andrefinement of the long term strategy which defines the competitive positioning of OSF Healthcare services.Along with these responsibilities, she also assists the organization and its leadership in ensuring the alignment of key strategic initiatives as well as marketing and business development plans.

In her current position, Michelle has led the creation of OSF Healthcare System's innovation agenda including health technology incubation, usability and simulation strategies, and venture capital investment strategies. She has led many transformation initiatives across the System including the implementation of Epic, organizational design transformation, population health strategy development, and the creation of a system wide program management office. Her past roles have included Senior Vice President, Performance Improvement Division (2008-2010), and Executive Director of Planning for the Information Technology division (2006-2008). Her professional accomplishments also include achieving a 6 Sigma Black Belt (2002) and 6 Sigma Master Black Belt (2003). Michelle has a Master's degree in psychology/social work from the Univ. ofIllinois.

Innovation in Patient Care: What it Means to the Frontline Nurse Today & Tomorrow

Lori Wiegand, MS, RN, DNP
Chief Nursing Officer
OSF HealthCare System

Dr. Wiegand is the Chief Nursing Officer for the OSF HealthCare System. As the Chief Nursing Officer, she is responsible for the practice of nursing Ministry-wide including ensuring consistent standards across the clinical settings and supporting and facilitating an interdisciplinary team approach to the delivery of care. The CNO endorses and advocates for the continued advancement of the profession of nursing at OSF HealthCare. Dr. Wiegand started her career at OSF Saint Francis Medical Center as an RN on the Medical Nursing Unit. She was promoted to Charge RN until she shifted to a new role as a 6 Sigma Master Black Belt. In 2007, she was promoted to become the Director of Nursing Operations and Care Management, and in 2009, she advanced to the position of Vice President Patient Care, Chief Nursing Officer. Lori was named Senior Vice President, Chief Nursing Officer for OSF Healthcare in September 2013. Dr. Wiegand earned her Doctorate in Nursing Practice from the University of Miami. She has a Master's Degree in Nursing Administration from Drexel University and a B.S. in Nursing from the Univ. of St. Francis.

What Innovation Looks Like in Quality & Safety Across the OSF Ministry

Stephen Hippler, MD
Senior Vice President of Clinical Excellence and Chief Clinical Officer,
OSF HealthCare System

Dr. Hippler is the Senior Vice President for Clinical Excellence Chief Clinical Officer for OSF HealthCare. He is responsible for several Ministry Services departments including: Clinical Quality Reporting, Clinical Quality and Effectiveness, Regulatory Readiness, Patient Safety and Clinical Research. Additionally, he continues with his current set of responsibilities as the Vice President of Quality and Clinical Programs for OSF Medical Group.

Dr. Hippler has been connected to The Sisters of the Third Order of St. Francis since 1988 when he joined the Medical Staff at OSF Saint Francis Medical Center upon completion of his residency training in Internal Medicine at the Mayo Graduate School of Medicine in Rochester, MN. He earned his Doctor of Medicine Degree from the University of Illinois College Of Medicine. Dr. Hippler is Board Certified by the American Board of Internal Medicine. He has authored articles about diabetes in professional medical journals and is a frequent presenter of continuing education topics throughout Central Illinois. He has participated in more than 50 clinical trials as a principal investigator and also serves on the board of directors for numerous non-profit community organizations.

Collaboration, Innovation and Functional Transformation for Better Patient Care Across the OSF Ministry

Jeff Tillery, MD
Senior Vice President and Chief Transformation Officer, OSF Healthcare System

Dr. Tillery is the Chief Transformation Officer of the OSF Healthcare System. In this role, he is responsible for shaping strategies and finding innovative care model solutions to advance the OSF Healthcare Mission and Vision. Dr. Tillery works in partnership with physicians and other clinical staff to grow and sustain an integrated healthcare delivery system.

Prior to this position, Dr. Tillery served as the Vice President and Chief Medical Officer for OSF Healthcare-Northern Region. He has led the development of a successful Physician Leadership Academy, and is the Ministry Champion for TeleHealth Services. More recently he has led the development of an Innovation Competency for OSF Healthcare, using that initiative as basis for Care Model Transformation for the OSF ministry.

The ARCHES Partnership and-Intellectual Property

Svetlana Vranic-Sowers, **PhD**
Senior Technology Manager
Office of Technology Management
University of Illinois at Urbana-Champaign

Dr. Svetlana Sowers is the Senior Technology Manager at the Office of Technology Management of the University of Illinois at Urbana-Champaign. She brings to OTM 15 years of software development and management experience from both Fortune 500 and start-up companies. Previously at Yahoo!, Svetlana led multiple projects and cross-functional teams to define and deliver products in the areas of cloud computing, data mining and data pipeline processing. While at Motorola Mobile Devices, Svetlana ran a USB lab, driving interoperability testing with phone carriers, and managing a team of 30+ local and global engineers. Dr. Sowers' portfolio focus is software and copyright.

Update on the Carle-Illinois College of Medicine

Rashid Bashir, PhD
Abel Bliss Professor of Engineering and Head
Department of Bioengineering
University of Illinois, Urbana-Champaign

Dr. Bashir is the Abel Bliss Professor of Bioengineering and Department Head. He was the Director of the Micro and Nanotechnology Laboratory (a campus wide clean room facility) at the University of Illinois, Urbana-Champaign, and Co-Director of the campus wide Center for Nanoscale Science and Technology, a collaboratory aimed to facilitate center grants and large initiatives around campus in the area of nanotechnology. He has authored or co-authored over 200 journal papers, over 200 conference papers and conference abstracts, over 120 invited talks, and has been granted 34 patents. He is a fellow of IEEE, AIMBE, AAAS, and APS. His research interests include BioMEMS, Lab on a chip, nano- biotechnology, interfacing biology and engineering from molecular to tissue scale, and applications of semiconductor fabrication to biomedical engineering, all applied to solve biomedical problems. He has been involved in 2 startups that have licensed his technologies. He has been involved in the realization and the founding of the Health Care Systems Center and the ARCHES partnership from its inception.

Teaching Neurosurgery Residents New Surgical Techniques: A Pilot Study

Anthony M. Avellino, MD, MBA
CEO, OSF HealthCare Neuroscience Service Line and Illinois Neurological Institute
Professor of Neurosurgery and Pediatrics, University of Illinois School of Medicine at Peoria
Anthony.M.Avellino@osfhealthcare.org

Introduction: Cranial endoscopic techniques are considered advancements over the traditional open techniques because they can achieve the same outcome with superior visualization and are less invasive, presumably due to reduced brain retraction. We embarked on a pilot study to evaluate the differences in teaching neurosurgery residents to perform corpus callosotomies (dividing the two cerebral hemispheres for better seizure control) in cadavers utilizing microscopic and endoscopic techniques.

Methods: Four residents, PGY1-4 levels, were asked to first perform the standard microscopic corpus callosotomy, which was then followed by performing the same procedure with endoscopic techniques at a second session. Time, incision length, craniotomy size, visualization, degree of brain retraction and extent of callosotomy were noted for each procedure during the training sessions.

Results: Total of eight fresh cadaver heads were used for the four residents in eight sessions. Generally, the higher level residents operated faster with less help. For the microscopic technique, the PGY4 resident was the only one able to completely resect the corpus callosum in its entirety. All residents struggled with endoscopic techniques. No resident was able to achieve adequate visualization with the endoscope.
The PGY2 resident was the only one able to reach the ventricle after extensive brain retraction. No one was able to perform callosotomy endoscopically.

Conclusion: Performing endoscopic callosotomies carry a steep learning curve. All residents had difficulty visualizing the anatomy endoscopically and were unable to complete the procedure to any degree.
This pilot study allowed us to reassess and modify our current methods for teaching new surgical techniques to residents. One option going forward is designing better optics and instrumentation system to create space for better visualization and maneuverability.

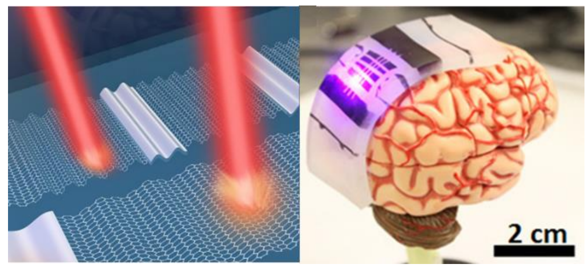
Anthony M. Avellino, MD, MBA, is presently the CEO of the OSF HealthCare Neuroscience Service Line and the Illinois Neurological Institute since August, 2014. As the CEO, he is responsible for the strategic, marketing/branding, clinical and operational design, development and delivery, and consolidation and integration of neuroscience services across the OSF HealthCare Ministry.

Prior to coming to OSF HealthCare, Dr. Avellino served as the Director of the University of Washington (UW) Medicine Neurosciences Institute and Chief of Neurological Surgery at UW Medical Center. Prior to leading the UW Medicine Neurosciences Institute, Dr. Avellino was the Chief of Pediatric Neurosurgery at Seattle Children's Hospital from 2007-2009; and the Residency Program Director of the University of Washington Department of Neurological Surgery from 2005-2009.

Dr. Avellino obtained his BS from Cornell University, his MD from Columbia University College of Physicians & Surgeons, and his MBA from The George Washington University School of Business.

Graphene-Integrated Biomedical Devices

SungWoo Nam
Assistant Professor
University of Illinois at Urbana-Champaign
Department of Mechanical Science and Engineering
swnam@illinois.edu

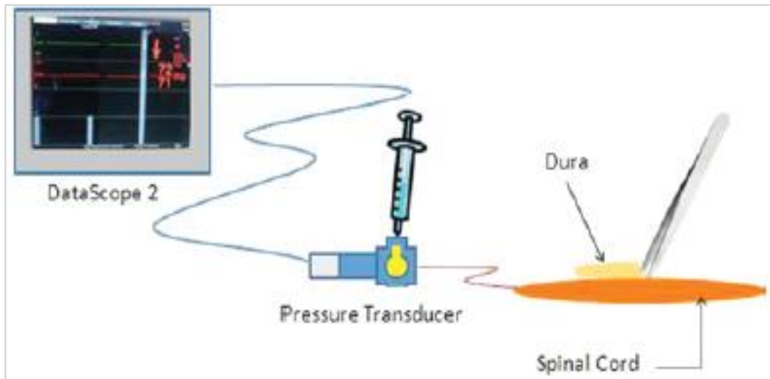


Superb electromechanical properties of graphene and two-dimensional (2D) materials provide a substantial promise for flexible electronics, advanced nanoelectromechanical and bio-integrated devices. For example, large elastic deformation can be achieved in 2D materials without significant perturbation of electrical properties. In this presentation, I present our progress on graphene-integrated biomedical devices, including graphene-coated catheters, and wearable graphene sensors. First, I will present low-temperature, direct synthesis of graphene and crumpled graphene coatings in biomedical devices, such as catheters. Graphene or crumpled graphene integrated catheters are expected to inhibit fibroblast growth and prevent catheter obstructions, benefiting from crumpled graphene's superhydrophobic surface characteristics. I will also present our recent development of superhydrophobic surface coatings based on another 2D material, MoS_2 nano-structures. Second, I will discuss our recent work on soft, wearable biosensors based on crumpled graphene devices. I will present our approach which enables mechanical flexibility and stretchability of graphene beyond its intrinsic material limit, and also discuss how we achieve device functionality under mechanical deformation. We believe our approach of crumpled graphene and 2D materials offers a unique avenue for creating advanced biomedical devices, and furthermore, these unique capabilities could be exploited in chemical and biological detection and conformal interface with biological systems in the future.

SungWoo Nam is an Assistant Professor in the Department of Mechanical Science and Engineering at University of Illinois at Urbana-Champaign (UIUC). He received his M.A. in Physics (2007) and Ph.D. in Applied Physics (2011) from Harvard University. Following the completion of his Ph.D., he worked as a postdoctoral scholar at the Department of Bioengineering at University of California, Berkeley. His current research program focuses on mechanical self-assembly of folded and crumpled graphene and 2D materials for strain-tolerant and flexible/stretchable sensor devices for biotic and abiotic applications. Dr. Nam is the recipient of the NASA Early Career Faculty (ECF) Award, AFOSR Young Investigator Research Program (YIP) Award, NSF CAREER Award, KSEA Young Investigator Grant, Doctoral New Investigator Award of the American Chemical Society (ACS) Petroleum Research Fund, and the UIUC Engineering Council Award for Excellence in Advising.

Synthetic Tethered Spinal Cord Model for Neurosurgical Residents Training

Julian Lin, MD
Residency Program Director
Department of Neurosurgery
University of Illinois College of Medicine, Peoria
jlin@uic.edu



Tethered spinal cord syndrome literally means the spinal cord is "stuck" causing problems such as pain and loss of neurological functions including motor, bowel and bladder. Treatment is surgical release or untethering of the spinal cord. Often times, this simply means carefully separating layers of tissues from the spinal cord. We developed a synthetic model to simulate this disease process and to facilitate learning of detethering techniques and published our initial results in 2013. We are here to report the current state of our model. The model was redesigned so it can be more modular and easily fabricated by the staff at Jump. A new automated data acquisition system was implemented using Arduino to give immediate result and feedback of the simulated procedure. The model can be rebuilt and reused by the staff at Jump within 24 hr of notice. The simulation can be performed within 45 minutes. The tracing from pressure monitoring within the simulated spinal cord gives several useful information such as simulation time, when the dura or the covering of the spinal cord was opened and if the spinal cord was breached or punctured. Secondarily, motion during simulation resulted in fluctuations of the pressure recording which can be interpreted as "steadiness." All these factors can lead to residents' quest for the perfect tracing. Finally, the engineering staff at Jump was able to fabricate and incorporate synthetic "dura" to the model that is suturable. Refining our surgical simulator for spinal cord detethering has introduced new and unique methods of learning to our residents where they can learn and practice a particular skill set at their own pace and time. The model also gives immediate and automatic result of the simulation and provides feedbacks that allow residents to gage their techniques and progress.

Mattei T, Frank c, Bailey J, Lesle Em, Macuk A, Lesniak M, Patel A, Morris M, Nair K, Lin J. *Design of a synthetic simulator for pediatric lumbar spine pathologies: Laboratory investigation* .
J Neurosurg Peds Aug;12(2):192-201. doi: 10.3171/2013.4.PEDS12540. Epub 2013 May 24.

Dr. Julian Lin is a Board Certified Pediatric Neurosurgeon with clinical interest in congenital disorders and hydrocephalus. He is currently developing simulation curriculums for the neurosurgery residents. He is also collaborating with Dr. SungWoo Nam on a graphene project. He is a member of the Alpha Omega Alpha honor medical society as well as the American Society of Pediatric Neurosurgeons. He enjoys working with the residents and has won two Teaching Awards.

A Hardware-in-the-loop Simulator for Safety Training in Robotic Surgery

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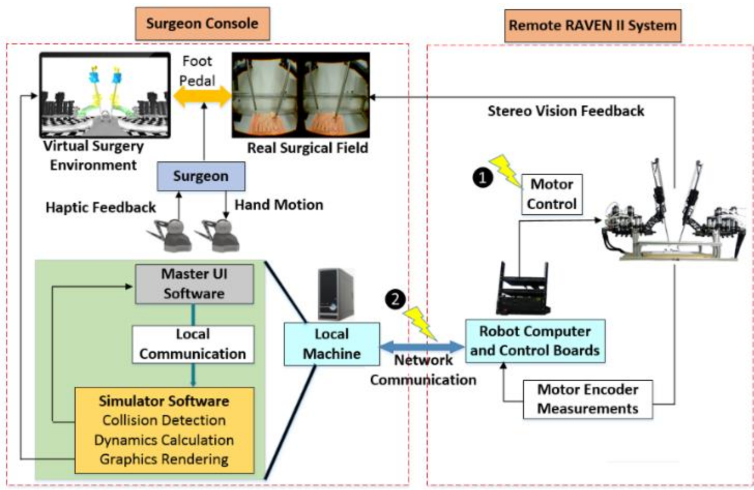

This work presents a simulation-based safety training simulator for robot assisted surgery. While adverse events occur rarely during training, they could be fatal to the patients if they happen during real surgical procedures and are not handled properly by the surgical team. In this work we propose a hardware-in-the-loop robotic surgery simulator with high fidelity of the robot motion in a simulated environment, which is capable of reproducing adverse events during surgery. The proposed simulator is built upon the Raven-II open source surgical robot, integrated with a simulated surgeon console and a safety hazard injection engine, which automatically injects faults into modules of the robot control software. We simulate representative safety hazards seen in the adverse events, related to da VinciTM robot, reported to the FDA MAUDE database. A novel haptic feedback strategy is provided to the operator when the underlying dynamics differ from the real robot states.

Reference

X. Li, H. Alemzadeh, D. Chen, Z. Kalbarczyk, R. K. Iyer, T. Kesavadas, “A Hardware-in-the-loop Simulator for Safety Training in Robotic Surgery”, in the IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2016)

Thenkurussi Kesavadas is the Director of Health Care Engineering Systems Center at the University of Illinois at Urbana-Champaign. Before coming to Illinois, Kesavadas was a professor in the Department of Mechanical and Aerospace Engineering at the University at Buffalo (NY), where he founded the University at Buffalo Virtual Reality Laboratory. He received his doctoral degree from the Pennsylvania State University in 1995. Kesavadas has been in the forefront of Virtual Reality and its application to medicine since 1993, when this field was still in its infancy. In 2004, Dr. Kesavadas was honored as the “Inventor of the Year” Western New York. He has also won numerous awards including SUNY Chancellor’s award for Innovation in 2004 and UB Visionary of the year award in 2010. He developed the world’s first stand-alone virtual reality Robotic Surgical Simulator RoSS and also co-founded two start-up companies. His own research interests are in the areas of medical robotics and simulation, virtual reality in design, haptics and human-computer interaction. Kesavadas is a Fellow of American Society of Mechanical Engineering and a member of IEEE.

Next Generation 3D Printed Infant Hearts for Pre-Operative Planning

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Lauren Grant, Graduate Student, Bioengineering
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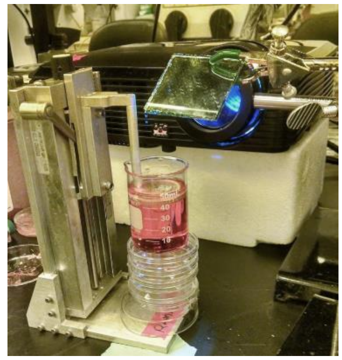
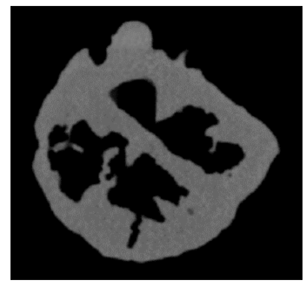


Simple SLA setup for rapid fabrication of heart models



Printed PEGDA heart and CT image of print

Surgeons have always faced the daunting task of operating on highly complex anatomical structures, such as the infant heart. With such a variety of congenital heart defects requiring high risk surgical intervention, it is difficult for surgeons to fully prepare for the various defects they will encounter. The ability to produce physical models of defective hearts that mimic the physical properties of the human heart, such as elastic modulus and wetness, could revolutionize preoperative planning and surgeon training. Using stereolithographic (SLA) fabrication, we can rapidly print high resolution anatomies with tissue mimicking hydrogel polymers. In our research, we use segmented CT images of neonatal hearts to 3D print accurate models of the patient heart. Upon fabrication, the printed hearts will be imaged using CT to validate the accuracy of the print. The physical properties of the printed material will then be evaluated and the model will be tested for its ability to withstand surgical repair techniques such as suturing. Once the material is validated, the defect within the printed model will be surgically repaired and subsequently CT imaged to validate the repair. After practicing the operation on a realistic, patient-specific model prior to surgery, surgeons will be better prepared to operate on the patient heart. These printed hearts can also be used as training tools for surgical residency programs. This is expected to be an iterative study design process which will allow us to quantitatively determine the efficacy of the surgical repair and also provide a method to access surgeon training.

Rashid Bashir is the head of the Bioengineering department at UIUC since 2013. He was the Director of the Micro and Nanotechnology Laboratory and Co-Director of the Center for Nanoscale Science and Technology from 2007 – 2013. Before that, he has been a faculty member at Purdue University and on the technical staff at National Semiconductor Corporation. He has authored or co-authored over 200 journal papers, over 180 conference papers and conference abstracts, over 110 invited talks, and has been granted 38 patents. He is a fellow of 6 international professional societies (IEEE, AIMBE, AAAS, APS, IAMBE, and BMES). His research interests include bionanotechnology, BioMEMS, lab on a chip, interfacing of biology and engineering from the molecular to the tissue scale, all applied to solving biomedical problems. He has been involved in 3 startups that have licensed his technologies. In addition to leading his own research group, he is the PI on an NSF IGERT on Cellular and Molecular Mechanics and Bionanotechnology (2009-2016) and PI on an NIH Training Grant on Cancer Nanotechnology (2009 – 2016). He is also the campus lead and Co-PI on an NSF Science and Technology Center (STC) on Emergent Behavior of Integrated Cellular Systems (headquartered at MIT, with partners at Georgia Tech and UIUC) (2009 – 2015 and renewed for another 5 years 2015 – 2020).

Toward Implementation of 3D Modeling in a Health System

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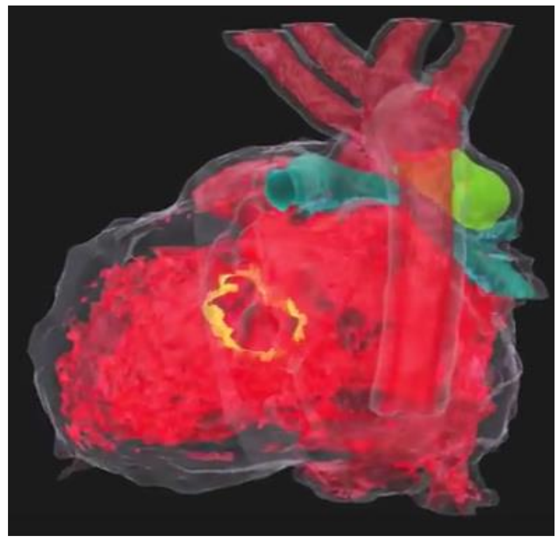
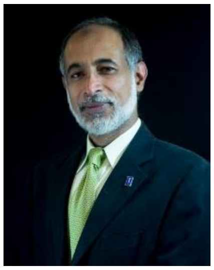


The value of 3-Dimensional replications of patient specific human pathology has emerged as a new tool to improve medical decision making. Currently, the process of going from standard medical images to 3D model remains a highly technical and manual process utilizing many specialized resource s. This limits accessibility and scalability toward broad impact in a health system. To address these limitations, we are developing a unique process to go from healthcare provider order entry to 3D model application. The process includes: order entry into the Electronic Medical Record (EMR), anonymization of Protected Health Information (PHI), external creation of 3D patient specific 3D models, optimization of content for key clinical questions as well as content delivery to practitioners through various formats (physical printed model, virtual reality, augmented reality or mixed reality), and documentation of impact to guide future development. For successful implementation into a health system, an integrated multi-disciplinary team approach is critical for realization. We will outline the critical elements and implementation proposal as well as identify our current research focus and future research potential.

Matthew Bramlet is Director, Congenital Cardiac MRI Program at the Children's Hospital of Illinois. His clinical training is specialized in children with congenital heart disease which focuses on complex hemodynamic relationships of anatomy and physiology related to the human circulatory system. He came to OSF to develop the Children's Hospital of Illinois congenital cardiac MRI program in 2009 and served as medical director of the congenital echocardiography lab from 2010 to 2015. The combination of his focus on 3D SSFP high quality MRI imaging sequences with Jump engineering resources pioneered anatomically accurate 3D congenital cardiac models resulting in improved surgical planning through improved complex anatomic understanding. This expertise led to a collaboration with the NIH's 3D Print Exchange as curator of the site's Heart Library, http://3dprint.nih.gov/collections/heart-library, a nationwide collaborative effort to improve the education and understanding of congenital cardiac anatomy through an open source initiative to build a comprehensive library of congenital cardiac 3D digital models. In 2015 he transitioned to his current role at Jump thanks to an endowment focused on advanced imaging and modeling techniques. His current research interests are focused on quality metrics, reproducibility, automated segmentation and health system access involving new 3D imaging and modeling techniques.

An Integrated Approach to Healthcare Delivery



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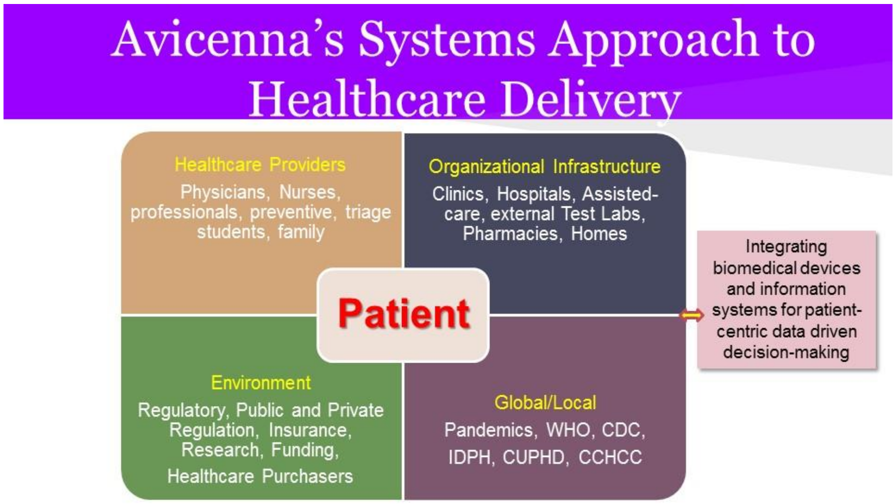
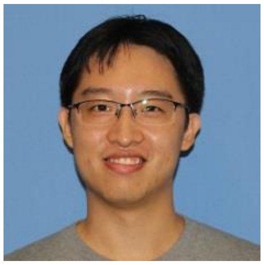


Innovations in biomedical technologies are critical to taking an integrated systems approach to healthcare delivery. This is particularly true in the case of unisured and underinsured demographics for patient-centric positive outcomes. However, all of this has cost associated with it, and someone has to pay for it from an array of stakeholders. Avicenna Community Health Center-a social entrepreneurial endeavor's approach to the intgreated healthcare delivery will be discussed, involving data-driven decision-making and analysis of both soft and hardware biomedical devices and tools.

Irfan Ahmad is Executive Director at the University of Illinois Center for Nanoscale Science and Technology (CNST); Research Faculty at the Department of Agricultural and Biological Engineering; and is a former Assistant Dean for Research at the College of Engineering (COE). He also is Co-PI/co-Site/ Innovation Director for the NSF-Industry/University Cooperative Research Center for Advanced Research in Drying (CARD). He specializes in conceiving and building of externally funded large multi-disciplinary and multi-institution centers and institutes; and serves as an executive committee member for a number of NSF-funded centers including on cancer nanotechnology, molecular mechanics, nanoBIO NODE and the Illinois Initiative for Advanced Robotic Surgery. Dr. Ahmad obtained his B.Sc. from the University of Agriculture, Faisalabad, Pakistan, M.S. and Ph.D. degrees from the University of Illinois all in Agricultural Engineering (ABE). His postdoctoral work was conducted on crop and nitrate sensing. His current research interests involve bionanotechnology, nanomedicine, sensors, agricultural machinery design, grain quality, and precision agriculture.

As an entrepreneur Dr. Ahmad was involved with IT24, an information technology company, and Buruj, an environmentally-friendly sensors development startup; and more recently helped found Avicenna Community Health Center (ACHC)- a social entrepreneurial endeavor, taking a systems approach to healthcare delivery.



Development and Evaluation of a Passive Hydraulic Simulator for Elbow Spasticity Replication

Yinan Pei[1], Jiahui (Carrie) Liang[1], Randy H. Ewoldt[1], Steven R. Tippett[2], Elizabeth T. Hsiao-Wecksler[1]
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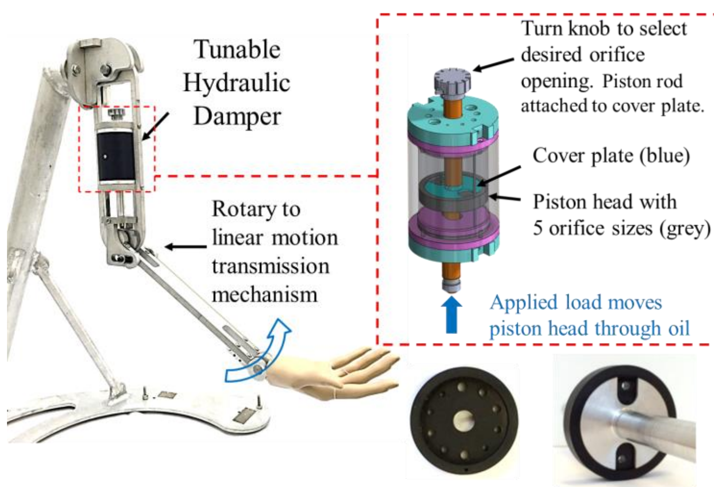
Spasticity is a stretch reflex disorder where joint movement resistance increases with stretch speed. Clinical evaluation for spasticity is performed by passively moving the joints of a patient and scoring the behavior using qualitative scales, such as the Modified Ashworth Scale (MAS). The subjective nature of the qualitative scale results in poor reliability and inconsistency of assessments, especially if repetitive practice is limited. Our goal is to develop a healthcare training simulator prototype that can reproduce different levels of spasticity, while also being portable, self-contained, hydraulic-based, unpowered (passive) and low cost. This system relies on designing and fabricating a novel passive piston-cylinder damper filled with viscous silicone oil to generate a wide range of speed-dependent feedbacks with respect to different input angular velocities at the elbow. Resistive torque is created when fluid flows through the moving piston head, which has selectable orifice sizes. Damper design was influenced by analytical fluid mechanics modeling and experimental prototyping. Our current simulator prototype is capable of replicating most aspects of spasticity for MAS levels 0-4 during elbow flexion without the need of any computationally expensive control scheme. Future work will address the catch-and-release aspect of spasticity, spasticity during elbow extension, and rigidity at the elbow. Rigidity is a position-dependent muscle resistance. This project is supported by the Jump ARCHES program.

Score	Modified Ashworth Scale (MAS) for spasticity
0	No increase in muscle tone
1	Slight increase in muscle tone, manifested by a catch and release or by minimal resistance at the end of the range of motion when the affected part(s) is moved in flexion or extension
2	Slight increase in muscle tone, manifested by a catch, followed by minimal resistance throughout the reminder (less than half) of the range of motion
3	More marked increase in muscle tone through most of the range of motion, but affected part is easily moved
4	Considerable increase in muscle tone, passive movement difficult
5	Affected part is rigid in flexion or extension



Yinan Pei is a current graduate student in Department of Mechanical Science and Engineering at the University of Illinois at Urbana-Champaign. He completed his bachelor's degree in Civil Engineering from University of California Los Angeles in 2015.

Human and Data Analytics Interactions in Readmission Risk Assessment

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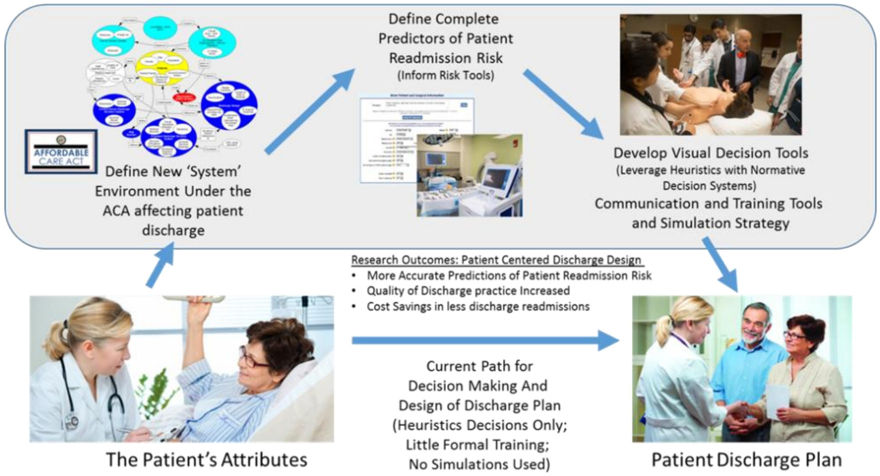

Approximately 20 to 25 percent of patients discharged from primary healthcare facilities are readmitted within 30 days at a cost of roughly $42 billion dollars per year. The Affordable Care Act (ACA) of 2010 directed Accountable Care Organizations (ACOs) to seek improvement of the quality of discharge care while integrating a new "pay for performance" business model which includes financial penalties for unplanned 30-day readmissions. This, along with incentives within the ACA for adoption of electronic health records (EHR) has motivated the rapid creation of new, data analytics based predictive risk estimation technologies. These new technologies are often proposed without methods to guide their design or implementation. The impact of inserting them into the traditional human-expert-centered decision process is not well understood. Research conducted on expert heuristics within the healthcare industry has not been specific to patient readmission risk estimation. The human-computer interactions are the subject of study here, specifically how data analytics results might influence case manager readmission risk estimation through the anchoring and adjustment heuristic. This presentation shows the results of an experiment designed to simulate the reactions of healthcare providers to inputs from new readmission risk estimation technology. Results indicate that the healthcare workers' estimates were anchored on the data analytics output, but were then adjusted according to their own expertise. The healthcare workers further adjusted their estimates in response to new input from another human expert. Thus anchoring and adjustment was observed.

Deborah L. Thurston is a Gutsgell Professor of Industrial and Enterprise Systems Engineering, Director of the Decision Systems Laboratory, and Co-Director of the Hoeft Technology and Management Program at the University of Illinois. She earned the MS and PhD from the Massachusetts Institute of Technology. As one of the first researchers in the then-emerging field of engineering design theory and methodology, she brought mathematical rigor to design decision problems of overwhelming complexity by formalizing methods for making rational tradeoffs under uncertainty. Her research has been funded by the National Science Foundation (NSF), the Environmental Protection Agency, and a number of industries. Professor Thurston received the prestigious NSF Presidential Young Investigator Award, two Xerox Awards for research excellence, four awards for undergraduate advising, and five best paper awards. She has served as technical area editor for the *ASME: Journal of Mechanical Design* and *The Engineering Economist,* and on several NSF panels to help define the national research agenda in decision based and sustainable design.

Camera-based system for assessing fall risk and exercise compliance

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In collaboration with Jacob J Sosnoff, Vignesh Ramkrishnan and Yaejin Moon

Falls are a serious health concern and are the leading cause of accidental death and injury in older adults. The first step to preventing falls and reducing the risk for falling is the identification of the modifiable risk factors. This will identify those at risk for falling and provide appropriate targets for the design of therapeutic interventions that are aimed at reducing falls. Screening methods currently in use are either subjective and based on self-report, or they utilize objective tests of balance and gait to quantify impairment. However, quantitative tests require clinical expertise to be implemented, and necessitate visits to a clinical facility. An alternative approach presented here utilizes commercially available video technology (Microsoft Kinect camera) to screen older adults for fall risk. The system provides an objective and quantitative measurement of posture and balance by capturing the kinematics of 20 major joints in the body (see Fig. 1). It is fully automated, and an on-screen avatar guides the elderly participant through the various tests such as postural sway, timed sit-stand, and the four-squares step test. The system can also incorporate tests for proprioception, visual acuity, and cognition. A second component of the system under development is the determination of exercise compliance in home-based settings. Those at risk for falling are generally prescribed an exercise regimen but ensuring compliance in the home-setting is extremely difficult. The system incorporates a machine learning algorithm to determine whether a prescribed set of exercises are performed correctly. The fall-risk system contains client and server subsystems so that fall risk assessment and exercise compliance can be monitored remotely by a clinician.

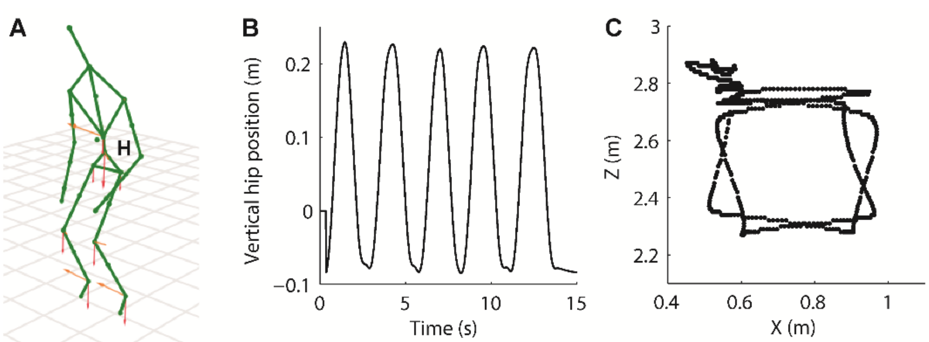
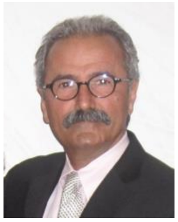


Figure 1*: Fall-risk assessment analyses.* ***A****. Joint positions (20) reported by the Kinect camera (H: hip).* ***B****. Hip motion during 5 sit-stand repetitions allows estimation of range of motion and time taken for the test.* ***C****. The hip position in the four-squares step test. X-Z is the horizontal plane (floor, looking down).*

Rama Ratnam is a Senior Research Scientist with the Health Care Engineering Systems Center at the University of Illinois at Urbana-Champaign, and a Principal Scientist with the Advanced Digital Sciences Center, Illinois at Singapore. He is a former assistant professor of neurobiology at the University of Texas at San Antonio. He received his bachelor’s degree in chemical engineering from the Indian Institute of Technology in Delhi, and his Ph.D. from Illinois in biophysics and computational biology.



Enterprise Terminology Platform IMO 2.0

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Objective: The goal was to test the IMO 2.0 Enterprise Terminology Platform, in combination with open APIs, to communicate with electronic health record applications like Open Epic and provide a foundation to rapidly create medical terminology-enabled applications for point-of-care use within electronic health record (EHR) systems.

Methods: This concept was tested in a "connectathon" event engaging developers with varying degrees of knowledge of IMO products and services. The use case involved two different systems for the problem list for same patient: one was the Epic FHIR toolkit; the other an older EHR created by the State of Indiana. The systems had different data structures and similar but slightly different lists of problems. Over the course of two days, an IMO team with UIUC CS interns developed a tool that would allow an end user to reconcile these different data streams into one comprehensive IMO coded problem list. The use case specifically pointed to the problem of reconciling problem lists for given patients. In addition, the service was adapted to reconciling lab results. IMO provided access, documentation, and training on the use of IMO 2.0 ETP services. The teams built their applications based upon the Open Epic framework and IMO 2.0 ETP services.

Results: In just two days, the team developed a tool that appeared to have a great deal of use in the clinical world. The User Interface metaphors for any such tool are extremely important, and the team adopted many of the concepts common in the shareware tool Beyond Compare to move data back and forth between data streams. Though there the data structure of the original data stores was highly complex, once the team had built the tool using resources from IMO 2.0 ETP, the data comparison mechanics became very easy to develop and structure. The key to effectively comparing data streams involved the use of a "meta" data stream that could be used to group like items from a larger data set so that similar items show up close to one another within a comparison list. Once the list is created, an interface needs to exist so the UI can move an item from one list to the other. The team used IMO's "grouping" technology to reconcile patients with long problem lists. They also developed a meta language for working with the codes that identify lab reports.

Conclusion: While the practice of medicine, and compliance with the Meaningful Use (MU) Stage 1 and 2, has recently standardized on the use of Electronic Medical Records, the Centers for Medicare and Medicaid (CMS) final rule on MU Stage 3 for the EHR Incentive Program adds new dimension to point-of-care applications requiring decision support services. This project showed that the format of records extracted from different EHR's is widely and divergent. Each system had different version of codes, no codes (free text) or, in some cases, wrong codes assigned to given term/result. Thus, in order to prevent data silos and allow for the evolution of standards, having access to a terminology platform that allows for the migration and comparison of different data streams using correct codes is paramount to preservation of clinical intent and reconciliation services.

Dr. Naeymi-Rad is CEO, Chairman of the Board and co-founder of Intelligent Medical Objects, Inc. His PhD is from the Illinois Institute of Technology in Computer Science. His thesis work focused on medical vocabulary to support Data Base Translation, Information Retrieval, Intelligent Medical Records, and Expert Systems.

Multimodal Cardiac Phantom for Imaging-based Modeling, Simulation, and Standardization

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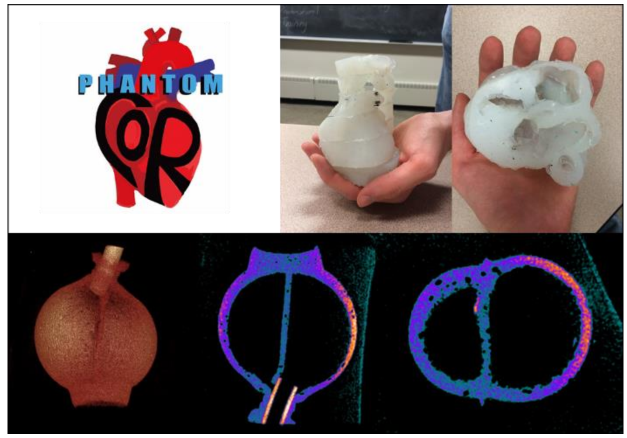

The availability of affordable, multimodal cardiac phantom can be of crucial importance in the development and validation of various acquisition sequences, protocols, and image analysis methods, and studying myocardial infarction, pathological flow dynamics, and segmental dyskinesis through modeling and simulation. A group of UIUC interdisciplinary undergraduate students in collaboration with my research group at the Experimental Molecular Imaging Laboratory in Beckman Institute is developing a novel multimodal dynamic heart phantom which mimics the cardiac shape as well as the X-ray CT, MRI, and ultrasound imaging properties. The two-chamber cardiac structure provides asymmetric left ventricular motion. Pathologic conditions will be simulated by scarred regions of various stiffness and the application of fluid pressure profiles. The phantom allows not only testing of image acquisition protocols and image analysis techniques but could be used to simulate the anatomy and pathological physiology of the heart, or measuring mechanical properties of therapeutic cardiac patches or scaffolds during the cardiac cycle.

A prototype of the dynamic multimodal cardiac phantom is currently being tested using PET/CT, MRI, and ultrasound modalities. Future developments will include design and construction of 3D printed cardiac phantoms based on the collection of digital scans of pathologic human anatomic hearts available through NIH 3D Heart Library and OSF Peoria.

Wawrzyniec Lawrence Dobrucki is currently Assistant Professor in the Department of Bioengineering at the University of Illinois at Urbana-Champaign and holds a faculty position at Beckman Institute of Advanced Science and Technology. He directs the Experimental Molecular Imaging Laboratory (EMIL). His expertise is in molecular multimodality imaging, and his fields of professional interests include the development of novel targeted microSPECT/PET-CT imaging strategies to study biological microenvironments in vivo, standardization of small animal imaging protocols, and development and validation of novel SPECT/PET radiotracers and CT contrast agents. Prof. Dobrucki received his Ph.D. in Chemistry from Ohio University, Athens, OH in 2003, and M.Sc. degree in Bioengineering from Technical University of Wroclaw, Poland and Technical University of Hamburg, Germany. Prior to joining the Department of Bioengineering as tenure-track faculty in 2013, Prof. Dobrucki was a junior faculty member at Yale University School of Medicine and Senior Research Scientist at Beckman Institute where he directed the Molecular Imaging Laboratory (MIL) in the Biomedical Imaging Center (BIC).

Visualization and modeling of musculoskeletal tissues

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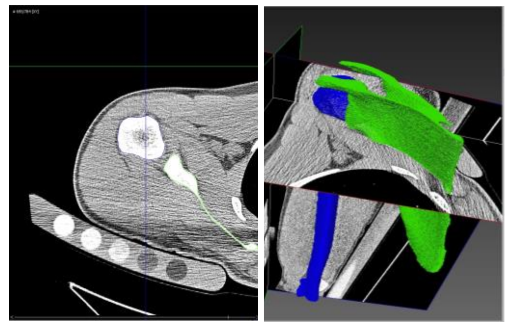

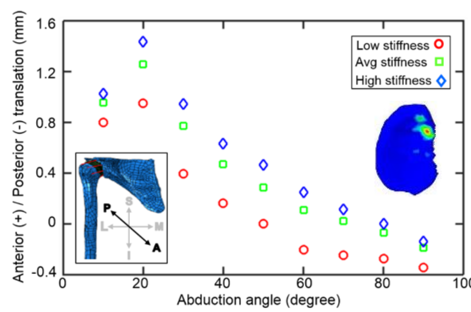

Human movement is the result of active muscles that drive the movement of our bones while ligaments, joint cartilage, and other passive soft tissues ensure stability during movement. This coordination can be disrupted with age, disease or injury and is often first identified via medical imaging of the structures using either magnetic resonance imaging (MRI) or computed tomography (CT). While imaging sequences and on-screen visualization tools have improved, their translation to clinical training or decision making has been limited. Our group seeks to bridge this gap by incorporating biomechanical and structural properties of musculoskeletal tissues into three-dimensional models within a virtual environment. We have developed efficient image segmentation schemes for assessing bone and cartilage that allows for three-dimensional models to be 3D printed for visualization of fractures, joint defects, or other pathologies. These models can also be incorporated into a virtual environment that allows for complete visualization of the objects. Current work includes the development of a mechanical database of tissue response to different treatment parameters using Monte-Carlo style finite-element simulations, validated by mechanical testing. When combined with the 3D visualization, clinicians and learners can evaluate and predict the biomechanical consequences of surgical approach and technique within a virtual environment. Our aim is to develop intelligent, biomechanics-based feedback tools that can be used by medical learners without the need to wait for on-the-job training opportunities and in real-time for clinicians to make informed, predictive decisions. The development of this tool serves as a platform for other simulation tools that can be applied for orthopedic-based training.

Mariana Kersh is an Assistant Professor in the Department of Mechanical Science and Engineering at The University of Illinois at Urbana-Champaign and is Director of the Tissue Biomechanics Laboratory. Dr. Kersh first received a BA in English from The University of Texas-Austin, then a BS and MS in Mechanical Engineering, and PhD in the Materials Science Program from The University of Wisconsin – Madison as a National Science Foundation Pre-Doctoral Fellow. She was a McKenzie post-doctoral research fellow in the Department of Mechanical Engineering at the University of Melbourne and the awardee of the 2013 ANZORS Early Career Researcher Award. Her research uses experimental methods to (1) evaluate mechanical and structural properties of bone, cartilage, and ligaments and (2) assess their contribution to joint stability. This data is also used in finite element simulations to evaluate intervention techniques and develop novel hypotheses of tissue structure-function relationships.

Altered PFC activation during Locomotion in Older Adults with Multiple Sclerosis

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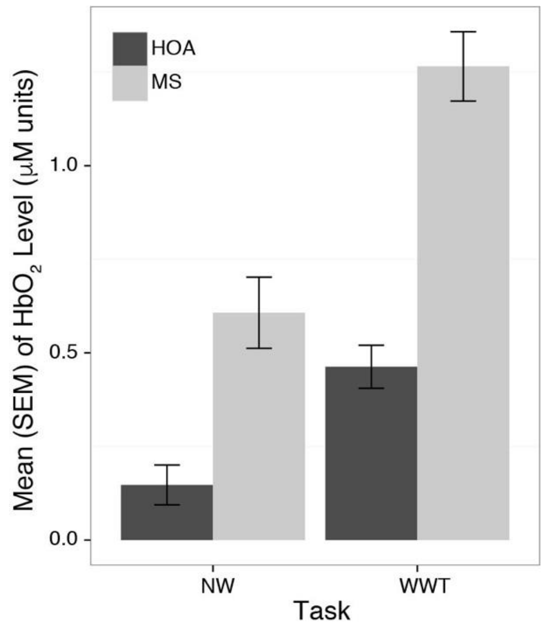
The present study used functional near infrared spectroscopy (fNIRS) to evaluate real-time neural activation differences in the prefrontal cortex between older adults with multiple sclerosis (MS) and healthy older adults (HOA) during simple (Normal Walk; NW) and attention-demanding (Walking While Talking; WWT) walking tasks. Older adults with MS and HOA underwent fNIRS recording while performing the NW and WWT tasks with an fNIRS cap consisting of 16 optodes positioned over the forehead. The results revealed that the MS group had greater elevations in prefrontal oxygenation levels during WWT compared to NW than HOA during comfortable paced walking. However, there was no gait performance difference between groups. These findings suggest that individuals with MS might be able to achieve similar levels of performance through the use of increased brain activation. This study is the first to investigate brain activation changes during simple and attention-demanding walking tasks in MS using fNIRS.



Manuel E. Hernandez received the B.S. degree in mechanical engineering from Cornell University, Ithaca, NY, USA, in 2003, and M.S. and Ph.D. degrees in biomedical engineering from the University of Michigan, Ann Arbor, MI, USA, in 2005 and 2012, respectively. He completed his post-doctoral training in neuro-science at the Institute for Neural Computation at the University of California-San Diego, La Jolla, CA, USA, in 2014. He joined the faculty as an Assistant Professor at the Department of Kinesiology and Community Health at the University of Illinois at Urbana-Champaign in 2014 and is currently the Director of the Mobility and Fall Prevention Research Laboratory. His research interests include biomechanics, motor control, and neuroscience in older adults.

Automating urine output measurements to improve acute kidney injury diagnosis and management

Jay K. Joshi, MD MBA
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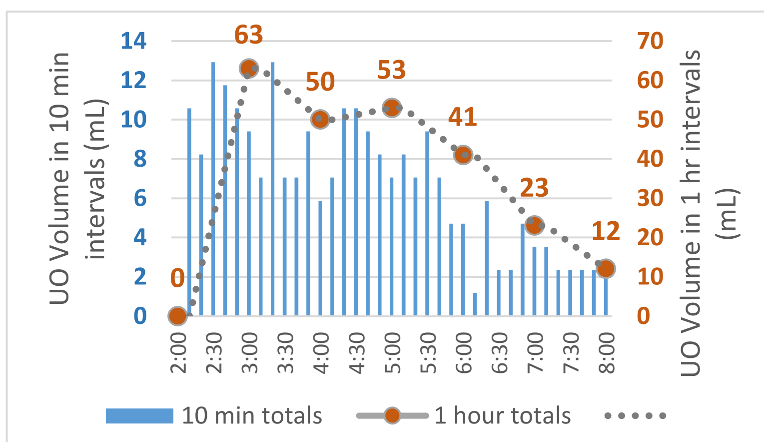
Our product addresses the limitations that exist in current medical technology using urine output specifically to diagnose Acute Kidney Injury (AKI), a complication that affects 20%-60% of all ICU patients. Urine output is an important vital sign used in treating patients with AKI. There is a direct correlation between patient mortality, and the number of and duration of low urine output episodes. Patients who then develop in-hospital AKI are at a 3x higher risk of death and cost an additional $15,800 to the hospital.

Currently, urine output measurement and recording is an inefficient and imprecise process relying on assessing the amount of urine in the transparent, pliable plastic collection bag and entering the value in the chart. ICU nurses can spend as much as 7% of their time in this effort. The realities of a nurse caring for critically ill patients often leads to irregular monitoring of urine output. Current methods fail to detect 23% of low urine output episodes.

The device is an add-on adapter that fits between the Foley catheter and the distal tubing to measure urine output in customized, set intervals as the urine passes through. We integrate the output data into the hospital EMR. The technology in the device conforms to the behavior of ICU physicians and nurses: (a) the device can function at multiple orientations allowing the patient to move without disrupting measurements, (b) the data presents urine output measurements in set intervals which provide the ideal number of data points necessary for clinical decision making, and (c) the device fits within existing Foley catheter drainage tubes preventing any significant change to nursing workflow.
The technology fits the cost structure of hospital spending: (a) the unit economics of each device fits the set budget allocated to urine measuring devices, and (b) the device is sold alongside existing Foley catheters, allowing the hospitals to maintain their sales contracts with large vendors of Foley catheters.

In a benchtop test, we simulated the function of a kidney by varying the flow rate over time using a peristaltic pump while our device measured and displayed the data readings. The above graph shows the volumetric readings at intervals of 10 min and 1 hr. In the same test, we also measured the accuracy rates of our device and traditional, manual measurement methods and determined these to be 2.5% and 9.4%, respectively. Our data demonstrate that our device provides frequent and accurate urine output readings.



Dr. Jay Joshi is a practicing primary care physician with a keen interest for innovations in health care. He started Output Medical as an intern at the University of Illinois Medical Center and had led the venture from initial intellectual property creation through its first round of funding. He received his Medical Doctorate from the University of Illinois Medical in 2009 through the accelerated MD/BS medical program, and received his Master's in Business Administration from the University of Chicago Booth School of Business in 2011. He completed his internship at the University of Illinois Medical Center in 2012.

Results & Next Steps for 3D Avatar Models Applications in Healthcare

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Director, Interprofessional Education
Jump Trading Simulation and Education Center

Donald Halpin, MS
Healthcare Systems Engineering Consultant
Jump Trading Simulation and Education Center

Personal Health Record systems (patient portals) are often underutilized due to the patient's lack of medical knowledge to understand the messages and results delivered by the portal as well as the often confusing manner by which the portal presents the information. The *Application of 3D Avatar in Health Care* ARCHES grant, a collaboration with Dr. Thomas Huang of UIUC's Beckman Institute, explored the potential to integrate 3D avatars with speech capability into patient portal systems. Our expectation was that the integration of avatars would increase portal usability by mitigating gaps in the patients' health literacy and improving the interface with a more user-friendly presentation.

This talk reviews the results of that effort including test subject reactions to the avatars (acceptance, information understanding and retention), subject health literacy and its impact on interfacing with the avatar, and considerations on 'the uncanny valley' - the concept that human replicas that appear almost, but not exactly like real human beings, elicit feelings of eeriness and revulsion among some observers.

Dr. Willemsen-Dunlap completed both her nurse anesthesia training and PhD in Science Education from the University of Iowa where she accepted a dual appointment in the College of Nursing and College of Medicine. She currently serves as the Director of Interprofessional Education at Jump Trading Simulation and Education Center, working in interprofessional education, the neurodynamics of healthcare team interaction, and healthcare safety management. She continues to practice as a nurse anesthetist as OSF Medical Center in Peoria, IL.

Mr. Halpin is a Healthcare Systems Engineering Consultant at the Jump Trading Simulation & Education Center in Peoria, IL. He earned his MS in Aeronautical Sciences from Embry-Riddle Aeronautical University in 1995 and his BS in Electrical Engineering from the US Air Force Academy in 1984. His work at Jump focuses on interprofessional education development and socio-technical innovation, particularly translating proven aviation risk assessment and management tools into healthcare. He retired from the USAF after a 28 year career which included two command tours, deployments, strategic planning & assessments in the Pentagon, political-military affairs at US Pacific Command, and a defense officer fellowship at the Hoover Institute, Stanford University, CA.

Providers Like Me

Mike DeCaro
Manager of Data Engineering
Intelligent Medical Objects, Inc.

Objective

The "Providers Like Me" project classified providers by similar patient case-mixes to create potential clinical social networks. The goal was to create a model that is able to connect providers with one another in order to leverage the knowledge base of care delivery, improve treatment and outcomes, and enable research.

Methods

We created a model that takes an entity (provider, patient) and returns resulting entities ranked by similarity. Given access to logging data that contains full patient problem list extracts from outpatient clinics across the United States, we utilized IMO's Intelligent Problem List (IPL) problem categorization and clustering to determine patient case-mixes. Utilizing a three-month study of problem list data, we determined how many patients had at least one problem in each of the IPL categories. We calculated the proportion of patients per physician presenting with at least one problem in each category to determine similarity scores between providers.

Results

The graphical display for Similarity using Category and Cluster for problem identification, shown in Fig 1, utilizes both the broad category of IPL's groups and the sub-categories (clusters). Each of the nodes in this display is a single provider and the connecting lines link each provider to their single-most similar provider. Sets of providers are colored based on the entire linking chain.

Figure 2 depicts another possible use-case, focusing on a specific provider and ranking all providers based on similarity to the one in question. Using the same weighted category/cluster case-mix, we obtained a ranked list of the 20 most similar providers to provider 1. This is an example of the proof we can find this link -- there are many options for display.

Figure 1. Similarity Using Cluster and Category

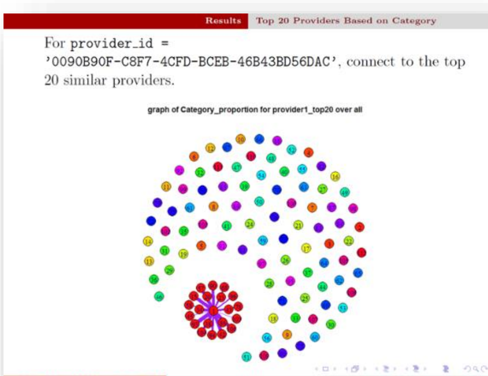
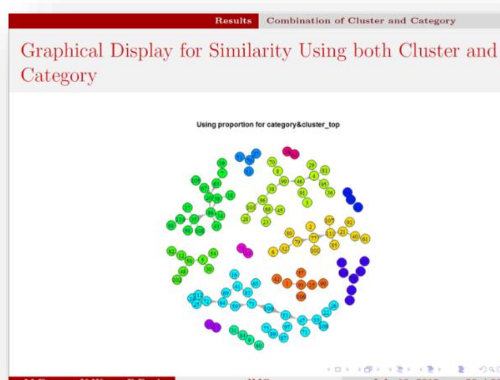


Figure 2. Provider Similarity Use Case



Mike DeCaro is the Manager of Data Engineering for Intelligent Medical Objects, Inc. He holds a Ph.D. in Mathematics from Northern Illinois University and a B.A. in Mathematics and History from Monmouth College.

Epidermal wearable biomedical devices: A human centered design study.

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Wearable technology is just breaking out of the early adopter stage of technology adoption, but the wearable market is expected to be worth $25 billion by 2019. Companies like Garmin and Fitbit are currently relying on watches and clip on products to meet their customer's needs. Those product categories have their limitations, in order to get accurate medical data from your body, direct skin contact is required to measure electrical signals generated by the body. Current wearables are unable to meet these requirements because people don't want to wear those products in ways that make them work, tight to the skin.

A National Science Foundation grant tasked our design team with developing the BioStamp RC product to be more friendly to its users. With the technological development of epidermal wearables comes a new challenge for design teams to design a new type of product that has never been seen before. Our group took a Human-Centered Design (HCD) approach to support the direction of our concepts through the ideation, development, and prototyping stage. At each stage of development these concepts were returned to the users to gain insight into emotional reactions to them.

This research gives insight into how people currently use wearables and how changes in that technology will influence the future of wearables. With a HCD research we developed insights into potential impediments that will influence how consumers adopt epidermal wearable technology.

Michael Hansen is a Design Researcher of Industrial Design in the School of Art + Design at the University of Illinois (Urbana-Champaign). As a designer, he has specialized in empathic research, human-centered design, and product prototyping. Before joining the University of Illinois, he worked as a Designer and Design Lead for Transco Products Inc., a company specializing in nuclear power plant safety equipment. His design work centered around producing safe and reliable equipment, with an emphasis on the life process of the products. His role as a leader at Transco inspired him to follow his passion of teaching. His current research is focused on biomedical wearable devices under a National Science Foundation grant and making those products more human-centered.

Training isometric force matching tasks in classical ballet postures in children with dystonic cerebral palsy

A. L. Tisha, , P. Chembrammel, N. Sankaran, R. McNish T. Kesavadas, C. López-Ortiz
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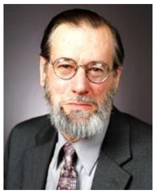
Cerebral Palsy (CP) is a non-progressive neurological disorder, commonly diagnosed at birth that causes abnormal muscle activity and coordination. Although the brain damage sustained is not progressive in nature, subsequent physiological adaptations may cause changes in muscle structure, function, and composition [1]. Ten percent of children with CP have dystonia and seek medical assistance at higher rates than other forms of CP. There is no cure for dystonia and rehabilitation exercises are unknown. We have designed a noninvasive, game-like movement puzzle, for children with dystonic CP. This novel system encourages classical ballet movements in a virtual reality (VR) environment. The game is created by using dimensionality reduction of force efforts, and efforts to solve it progresses one through the game. This system has several elements that come together to create a non-invasive strategy for corce control assessment and rehabilitation. The first is a six-degrees of freedom robot (KUKA Youbot, Augsburg, Germany) which facilitates hand movements through specific points in space. A force transducer (ATI Industrial Automation, NC, USA) is placed at the end effector of the robot. Attached to the force transducer is a custom made mount designed to enable children with dystonic CP to grasp and effectively exert forces to play the game. The game was designed in VR using Unity (Unity Technologies, US) engine. The purpose of using a game is to provide an immersive and enjoyable environment for the child who is undergoing rehabilitation. The VR environment is accessed through an Oculus Rift (Oculus VR, LLC). The movements experienced by the participants will be quasi-static in nature. The participant will have to exert forces in several pre-specified directions in the VR environment. Each set of quasi-static movements occur at several points in real space as guided by the robot. The forces exerted onto the force transducer serve as the input to the game. These forces are then filtered using principal component analyses and the resultant data is used as feedback. Our system differs from mainstream rehabilitation in that it uses principal component analysis of forces and torques exerted to provide feedback to the participant in a game-like environment.

References:

[1] Oskoui M, Coutinho F, Dykeman J, Jette N & Pringsheim T (2013) An update on the prevalence of cerebral palsy: a systematic review and meta-analysis. Developmental Medicine and Child Neurology.

Dr. Citlali López-Ortiz is an Assistant Professor at the Department of Kinesiology and Community Health in the College of Applied Health Sciences at the University of Illinois at Urbana-Champaign. She directs the Neuroscience of Dance in Health and Rehabilitation Laboratory where she is developing the scientific basis for dance as therapy for rehabilitation of movement disorders and augmented motor learning.



Population Health Management with Passive Mobile Monitors using Smartphones

Bruce Schatz, Department of Medical Information Science, schatz@illinois.edu
Anita Ung, Department of Internal Medicine, College of Medicine
Qian Cheng, Department of Computer Science, University of Illinois at Urbana-Champaign
Jennie Hsu-Lumetta, Department of Adult Medicine, Carle Foundation Hospital, Urbana IL

System responses to changes are strongly biased by how much patients can advocate for themselves and access the system. What if there were more equitable, efficient triggers to direct scarce healthcare resources to the patients who need it, at the time they need care? Since mobile phones are ubiquitous in today's populations, even among chronic older patients, they are the perfect tool for such triggers. *We have developed unique technology to transform every mobile smart phone into a continuous passive monitor* -- patients need only carry their phones during daily living—while back end analysis using statistical modeling will start actions only when status changes.

We focus here on the major class of lung patients, that of Chronic Obstructive Pulmonary Disease (COPD). Since COPD is a disease of progressive decline, punctuated by intermittent exacerbations, remote monitoring of health status in real time would improve healthcare quality — making management of this large population more equitable and cost effective without increasing demands on already stressed primary care networks. There are nearly 28M potential sufferers of this disease in the United States alone, with half of the cases currently undiagnosed, according to the CDC and the COPD Foundation. Given that this is 13% of the Medicare population, each status needs different treatment.

We have published results of predictive models for pulmonary function and oxygen saturation, based on 6 years of research with 100 cardiopulmonary patients within 3 health systems. These patients performed a 6 minute walk test under medical supervision in a rehabilitation clinic, the standard assessment. While walking, the patients carried a smart phone with custom software for recording the embedded sensors. We evolved the computation of the pulmonary function from motion sensors for different categories of health status, using the international standard GOLD levels compared to medical devices. Our models support perfect prediction of GOLD level from phone sensors.

We are in the process of developing the new healthcare infrastructure for a population health research experiment with 1000 patients within a health system. The patients will simply use their personal smartphones as usual throughout their daily activities, while their pulmonary function is automatically computed with medical accuracy. This experiment will focus upon care routing, to determine the status level then the appropriate treatment for diagnosed patients. We are also planning experiments with case finding, where undiagnosed patients are measured to discover COPD status. This requires generating baselines of similar but healthy patients, to compare well to sick cohort categories.

This population measurement possible with passive monitors will lead to much greater efficiency in population management of chronic disease, so treatments can be adjusted closer to real time as pulmonary status changes, rather than when a patient is able to access the system.

Bruce Schatz is Professor and Head of the Department of Medical Information Science in the College of Medicine at the University of Illinois. He is also Professor in the Department of Computer Science and Resident Professor in the Carl Woese Institute for Genomic Biology. His collaborator group has published predictive modeling with phone sensors in American Telemedicine Association journals and American Medical Informatics Association conferences. He is co-author of the first technical book, with the medical director of the regional health system, on using mobile devices to revolutionize medicine and public health, "Healthcare Infrastructure: Health Systems for Individuals and Populations" (Springer series in Health Informatics, 2011). He is AAAS Fellow for originating web browsing and searching.

Deep Analytics Enabling Precision Medicine

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Key to the success of precision medicine is the integrative analysis of clinical and biological big data (e.g., genomics, metabolomics) with longitudinal data (electronic medical records). Such an integrated analyses allows for inferring small, but biologically meaningful knowledge, called actionable intelligence. This intelligence aids in the design of laboratory experiments and personalizing diagnoses and therapeutic choices. Developing a framework with such an integrated analytics is a non-trivial task, and not only needs rigorous engineering fundamentals, but also needs close partnership with clinical and biological experts. This talk will illustrate four key problems that pose analytical challenges in enabling precision medicine, the types of data and the solutions we have developed under the mentorship of Prof. Ravishankar K. Iyer, University of Illinois at Urbana-Champaign, and through collaborations with biologists and clinicians at the Carl Woese Institute of Genomic Biology, Mayo Clinic and National University Hospital, Singapore.

Identification of disease subtypes in depressed patients from the largest single-site clinical trial at Mayo Clinic using a combination of unsupervised learning and probabilistic graphical models such as the hidden Markov model. ***Inferring mechanisms of drug response in disease subtypes*** in the context of an anti-diabetic drug metformin and triple-negative breast cancer (TNBC), using mixture model-based unsupervised learning. Our tool first narrowed down the hypotheses to a few strikingly downregulated genes, and functional studies of one gene among the downregulated genes established metformin's mechanisms of cell-migration inhibition. ***Predicting risk of disease progression and drug response*** in lung adenocarcinoma and triple-negative breast cancer respectively using game theoretic model. Using competing relationships from the directionality in differentially expressed genes, our model has high accuracies in, a) evaluating the risk of lung adenocarcinoma from smoking and, b) drug response in TNBC patients of the BEAUTY trial at Mayo Clinic. ***Predicting disease-related hospital readmission from electronic health records***, in the Singaporean diabetic population using Factor Graphs, a type of probabilistic graphical models. Predicting long-term health complications warranting readmissions to the hospital is important to understand population-wide risk and predispositions to certain health conditions. This allows for a cost-benefit model for early surgical interventions to prevent future complications, thereby aiding in graceful aging and reducing healthcare costs.

Arjun Prasanna Athreya is a doctoral candidate in the department of Electrical and Computer Engineering at the Univ. Illinois at Urbana-Champaign, advised by Prof. Ravishankar K. Iyer in the DEPEND laboratory at CSL. His research interests are in applying statistical methods on clinical and biological big data to bring predictability in clinical therapeutics in the context such as cancer, complications in endocrinology and major depressive disorders. Arjun is a Fellow of the National Center for Supercomputing Applications and CompGen, and collaborates with Prof. Derek Wildman, Carl R. Woese Institute of Genomic Biology, Drs. Richard Weinshilboum, Liewei Wang and Rani Kalari of Mayo Clinic and Drs. Kee-Yuan Ngiam and C. N. Lee, National University Hospital, Singapore in his multi-disciplinary research under the CompGen Initiative and Mayo-Illinois Alliance. Arjun received his MS in ECE from Carnegie Mellon University, with interests in networks and system security.

Intelligent Problem List Reconciliation

Steven Rube, MD
Medical Director
Intelligent Medical Objects, Inc.

Background
A frequent problem in today's health information systems involves the comparison and reconciliation of complex data streams from two different systems, such as problem lists in electronic health records (EHRs). Long problem lists and lab results create "thickets" of data that are not easily compared. Complex medical data is often encoded in different data formats, and data silos develop because legacy data cannot be easily compared or integrated with newer data formats. This problem was described in a HIMSS Hackathon/Connectathon use case that took place in April 23-24, 2016 at the Indiana University School of Medicine.

Objective
The use case contained two very different systems for managing user data. Once system was the newer Epic FHIR toolkit; the other system was an older one created by the State of Indiana. Both systems had different data structures and similar but slightly different lists of data. Over the course of two days, an IMO team of five developers developed a tool that would allow an end user to reconcile these different data streams. The use case specifically pointed to the problem of reconciling lab results and problem lists for given patients.

Methods
We determined that the key to effectively comparing data streams involved the use of a "meta" data stream that could be used to group like items from a larger data set so that similar items show up close to one another within a comparison list. Once the list is created an interface needs to exist so the user interface (UI) can move an item from one list to the other. We used "grouping" technology inherent in IMO's Intelligent Problem List product to reconcile patients with long problem lists. We also developed a meta language for working with the codes that identify lab reports.

Results
In two days, we developed a tool that has great potential for use in the clinical world. The UI metaphors for any such tool are extremely important. We adopted many of the concepts common in the shareware tool Beyond Compare to move data back and forth between data streams. The challenge in developing such a tool involved the complexity of the data structure of the original data stores—a deep understanding the nuances of the source's data structures is necessary. However, once the tool was built, the data comparison mechanics became very easy to develop and structure.

Conclusion
While the practice of medicine has recently standardized on the use of Electronic Health Records, the format of these records is still widely divergent. In order to prevent islands of disparate data and allow for the evolution of standards, tools will need to evolve that allow for the migration and comparison of different data streams.

Dr. Steven Rube is IMO's Clinical Director. He received his M.D. from The Ohio State University College of Medicine and completed family medicine residency at Northwestern University. Prior to joining IMO he was the CMO and Executive Vice President for Empower Systems.

Activity Trackers for Patients

Kimberly Hasselbacher
Surgical Clinical Nurse Reviewer
OSF St. Mary Medical Center
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I am interested in developing a personal activity tracker for our patients. This tracker monitors patient activities, sleep patterns, diets and links to our electronic medical record when it's appropriate. Profiling physical activity has many applications in the healthcare arena. The most obvious is due to the relationship between physical activity and well-being.

My idea is to develop a patient name band with the ability to track their activities while hospitalized and link to our EMR. A care provider and patient would open the application and see their steps and sleep pattern to encourage patient interaction and engagement. Diet and fluid requirements could be added to the application as well. The tracker would be more accurate in goal measurement as opposed to "up with assist" documentation to assess the patient's physical status and VTE prevention.

In the outpatient setting, care providers could offer their patients the band for monitoring free-living physical activity. The band could link to our My Chart application for physician/nurse feedback with the patient. Ultimately it is the engagement strategies; individual encouragement, social competition and collaboration, and effective feedback loops that connect with human behavior. (Patel, MS, et al. JAMA 2015 Feb 3; 313(5):459-60).
The tracker would be valuable for reaching pre-rehab goals for patients planning an elective surgery.

There are many wearable devices available to purchase depending on your personal preferences for tracking of physical activity, caloric intake, sleep patterns etc. I believe we can use this technology to improve patient outcomes by transforming population health, managing chronic diseases and hospital readmissions.

Kimberly Hasselbacher RN, is a Surgical Clinical Nurse Reviewer at OSF St. Mary Medical Center in Galesburg, Illinois. She has been with OSF Healthcare for 27 yrs. Kim worked in Surgical Services for 17 yrs. She was Clinical Manager of the Medical-Surgical Inpatient area for 5 yrs. Kim was Site Manager for OSF Medical Group for 2 yrs.

Dynamic Myocardial Phantom for Calibration of Multimodal Imaging and Modeling Methods

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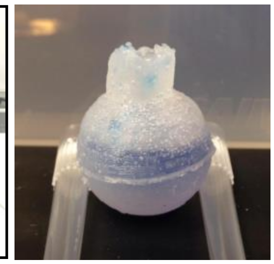

Annually, 735,000 Americans suffer a myocardial infarction with over 210,000 being a repeat incident. With over 500 post-incident treatment protocols in place, `accurate assessment of post myocardial infarction strains is essential and requires new imaging modalities. There is a need for a dynamic imaging phantom for acquiring myocardial images in order to test new imaging strategies. Currently available phantoms are unimodal and prohibitively expensive. Accordingly, PhantomCor provides a solution for multimodal, cost-effective heart phantoms. After consideration of various elastomeric materials, fabrication of the phantom includes usage of low-density biocompatible silicone due to its similarity to human tissue, relative cost, and ease in fabrication. Simulated plasma is delivered to phantom through 5mm tubing pumped by a stepper motor coded to simulate arterial pulse pressure waveforms. The phantom is submerged in acoustically conductive gel for ultrasound imaging. The device has produced successful results in PET-CT, ultrasound, and MR imaging. Projected to sell at $330, PhantomCor is much more affordable than commercially available heart phantoms. PhantomCor is a cost-effective, dynamic, multimodal heart phantom for the accurate calibration and testing of novel imaging techniques.

PhantomCor holds potential for use in medicine, research, and education. Medically, the phantom can help calibrate imaging machinery by providing baseline test cases for heart functionality. This facilitates a more personalized approach to individual cases and subsequently leads to more accurate imaging. Additionally, phantoms such as PhantomCor prove instrumental in the development of medical protocol. The phantom's research application includes facilitation in the simulation and analysis of various disease pathologies on heart functionality while its compatibility with SPECT, PET, X-ray CT, MRI, and other imaging modalities allows a quantification of these pathological effects. And finally, the device can serve as an education tool by imparting a visual understanding of the heart's fluid mechanics without necessitating a flesh heart. With the ability to image heart phantoms through various modalities, including SPECT, PET, X-ray CT, MRI and ultrasound, PhantomCor's novel approach will aid scientists and doctors in studying and lead to a better understanding of cardiovascular diseases.

Founded in 2015, the University of Illinois Urbana-Champaign Biomedical Engineering Society Design Team is a multi-semester design collaboration working to progressively improve a novel multimodal, dynamic heart phantom. Composed of interdisciplinary undergraduate students, the **PhantomCor team** is primarily held under the Bioengineering Department of UIUC.The PhantomCor Team's members include: Hiba Shahid, Joshua Au, Viraat Goel, Pierce Hadley, Alexander Hasnain, Boeun Hwang, Joshua Lew, Bara Saadah, Teresa Yang, and Hugh Yeh, and faculty collaboration with Drs. Lawrence W. Dobrucki and Brad Sutton. We hope to continue advancing and expanding the capabilities of the biological and medical field.

Simulating Nature, Enhancing Health: Exploring Therapeutic Applications of Natural Environments in Virtual Reality

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Exposure to natural environments can provide a wide array of benefits – such as improved immune function, attention, cognitive performance and mood; reduced pain, anxiety and depression; and faster recovery from stress and injury. We are developing a research project that will explore the extent to which exposure to natural environments in virtual reality (VR) can improve human health and wellbeing compared with exposure to real natural environments. Recordings of psychological (e.g., personality, mood) and physiological (e.g., skin response, cortisol level) measurements will be taken while subjects view and hear natural environment scenes in a virtual reality head mounted display or in the 'actual' natural environments from which the video and audio fields are recorded. Our study will add to an emerging field of research on the effects of simulated natural environments and provide the foundation for applied research on therapeutic applications for people with limited mobility or on bed rest, in assisted living facilities and hospitals, or in densely populated urban areas without access to nature.

Katherine Mimnaugh is a graduate student in the Department of Natural Resources and Environmental Sciences. She received her B.S. in Psychology and Spanish from the University of Illinois at Urbana-Champaign in 2008 and has been has been working as a lab manager in cognitive neuroscience laboratories with the Beckman Institute since that time. In that role, she has conducted research with adults of all ages using electroencephalography to study language comprehension, memory, and psychopathology. Her research interests include natural restorative environments, virtual reality, health care technology and neuropsychology.

Lifelike Training Device for Simulated Radial Artery Cannulation

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University of Illinois at Urbana Champaign Dept. of Bioengineering
SIMnext, Jump Trading Simulation and Education Center

Introduction: Radial artery cannulation is a common procedure in intensive care and surgical units where accurate monitring of intraarterial blood pressure is required. Failure rate for first attempt at radial artery cannulation is greater than 20% and second attempt failure rates are greater than 14%.[1] The purpose of this research is to examine the factors necessary to replicate the radial access procedure and to develop a realistic simulation device with an end goal of reducing costs and complications in the clinic.

Materials and Methods: The material utilized to mold the skin of the simulation device is Dragon Skin FX Pro (Smooth-On. Macungie, PA). FX Pro was chosen based on a survey of clinicians at OSF Peoria used to determine the most skin-like silicone material. The internal bone is fashioned from polyvinylchloride piping. The wrist joint is made up of a friction hinge and metal plating. The artery analog comprises Advantaflex tubing (Advantapure) and 3mm inner diameter electrical heat-shrink tubing. The fluid reservoir comprises a 500 ml latex intravenous (IV) delivery bag (Hospira. Lake Forest, IL). The pulse driving mechanism comprises a drive motor (DF15RMG, DFRobot.com) and a motorized linear rail for adjusting pulse pressure (SM-42BYG011-25, Sparkfun.com). The base and hinged IV box were fashioned from maple ply and common board wood.

Attached to the drive motor are four grooved pulley bearings which depress a length of metal wire fixed to the base at one end and a hinged lid of the IV box at the other. Underneath this lid in a fixed box lies the IV bag which is filled with fluid and connected to the arterial analog. Increased tension in the wire from the drive motor pulley bearings depresses the lid, thus increasing the pressure in the IV bag which drives the pulsatile fluid pressure through the replicated forearm.

Results and Discussion: Completion of initial device prototypes provides a realistic forearm anatomy and simulated pulsatile blood flow. Figure 1 presents the prototype and simulated pulsatile blood pressure as measured using an Omega PX 409 transducer. Note the accurate systolic and diastolic pressures in additon to the characteristic dicrotic notch.

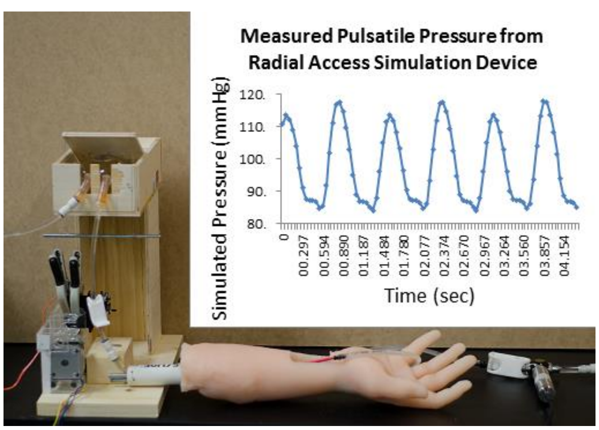

Figure 1. *Simulated pulsatile blood flow and waveform measured from hydraulic artery circuit using Omega digital pressure transducer. Note the dicrotic notch.*

Conclusions: It is evident from the data presented that accurate, simulated pulsatile blood flow can be achieved using the proposed prototype. Additionally, this device offers lifelike forearm and wrist anatomy along with realistic texture and puncture resistance. This device has been designed and developed with guidance from clinicians as they will be the primary users of the device. Overall, the advancements achieved with this device have the potential to improve intensive care patient outcomes, reduce first attempt puncture failures, and reduce complication related costs for clinics.

Acknowledgements to Eliot Bethke, Nathan Wetter Taylor, Lela DiMonte, Luis Soto, Saumya Khurana, Will Singleton, Dr. Brad Sutton, Dr. Jenny Amos, and Dr. John Vozenilek for their support and contributions to this work. Jump Trading, and Gary Durack are also acknowledged for their support.

References: 1. Neil R MacIntyre, MD Analysis of Radial Artery Catheter Placement by Respiratory Therapists Using Ultrasound Guidance. Respiratory Care, 2014. Vol. 59 No. 12 pg 1813-16.

Author Bio: Mark Doose is a senior in bioengineering at UIUC with a specialization in therapeutics. He has performed research and internships with the Beckman Imaging Center and SIMnext / Jump Simulation. He is Vice President of Theta Tau Professional Engineering Fraternity and Industrial Relations Chair for the UIUC Biomedical Engineering Society.

New medical device that identifies tear film biomarker to evaluate corneal integrity

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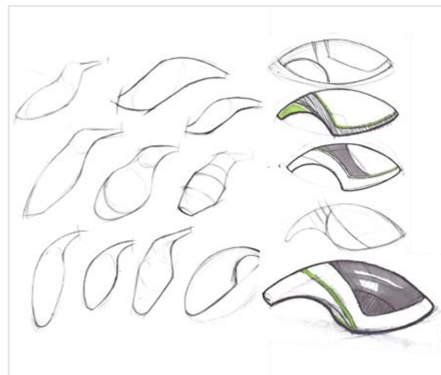

InnSight, Inc. is comprised of engineers, ophthalmologists, and business experts focused on delivering technology from the lab to the clinics to improve ocular care.
15% of ocular traumas in the US are open globe injuries. This is the most serious type of eye trauma where the full thickness of the outer wall of the eye is injured and can lead to blindness. In these cases, repair is needed within 6 hours of injury for the best vision outcomes. Current methods for evaluating corneal injuries require specific training and access to a slit lamp, a large and immobile device that is not typically available outside of the clinical setting. The OcuCheck is a point-of-care device that can quantify specific biomarkers in the tear film that result from micro leaks from the corneal wound after serious eye trauma. This is the first device of its kind to provide an accurate, objective measurement that can be used to assess the integrity of the corneal surface. The device can be used by staff of all skill levels and provides immediate results.

This technology is being developed by Leane Labriola D.O. and Dipanjan Pan PhD. (See technical poster by Khan et al). InnSight, Inc. also worked with industrial designers under the direction of Deana McDonagh PhD from UIUC to develop the design of the device. The designers researched the use of existing eye care tools and worked with ophthalmologists to ensure the device will be ergonomic and easy to use for the operator as well as being comfortable and nonthreatening for the patient.

Matthew Bowman is currently a graduate student at UIUC studying industrial design. He holds a bachelor's degree in manufacturing engineering. He led the design process, created CAD models, form prototypes, and final appearance models.

Gina Taylor is currently a graduate student at UIUC studying industrial design. Her studies focus on empathic design and user experience design with an application in the medical field. She collaborated in the design process and created visual graphics and materials for the product.

Non-Invasive Point-of-Care Diagnostic for Detection of Salivary Cortisol Concentration Using a Low Cost Electrical Biosensor Chip

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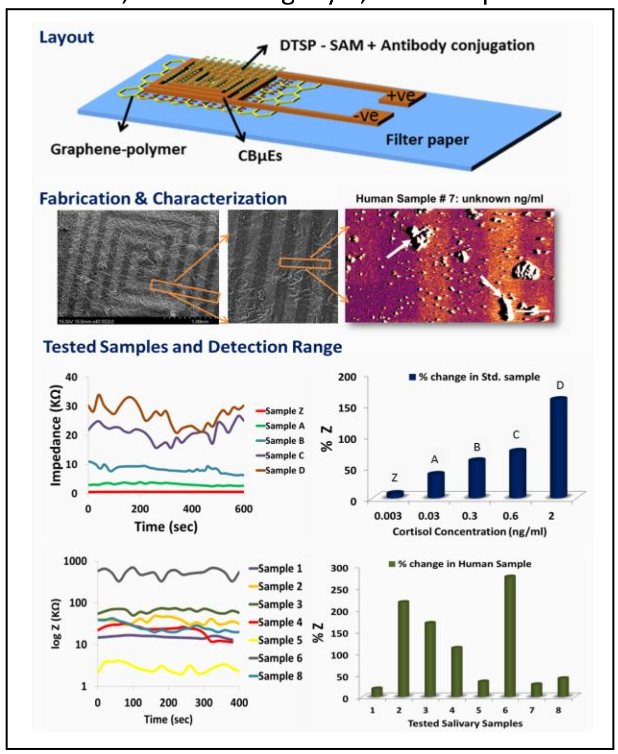
Increasing level of psychological stress due to the globalization, altered living style, and competition is becoming a serious concern in everyday schedule and life threatening diseases such as heart attack, depression, and brain pain are the health challenges faced by the most developed countries. Cortisol, a hormone commonly released upon stress, is a biomarker for numerous diseases and plays an important role in the regulation of various physiological processes and a cortisol level is elevated during the time of anxiety and depression. Though, in hospitals and clinics, there are relatively accurate methods available for computing the concentration of cortisol, but they are limited to the designated locations. Therefore, portable cortisol biosensor device could provide an interesting digital handheld instrument for researchers and clinicians who require onsite sample diagnosis. We have developed an on-chip disposable cortisol nano-biosensor through a layer-by-layer assembly process. In this work, in addition of testing the standard samples with known cortisol concentration, clinical study of 8 healthy subjects was successfully conducted to determine the potential usefulness of salivary cortisol (SC) sensors for estimation of cortisol detection limit of 3pg/ml. A disposable paper based, highly sensitive and label-free cortisol immunosensor chip is comprised of ring electrodes design fabricated on thin layer of graphene-platelets and polystyrene-block-polyacrylic acid, PS-*b*-PAA composite. Self-assembled monolayer (SAM) was produced for the formation of Dithiobis(succinimidyl propionate) (DTSP), which was finally used for an antibody-cortisol attachment onto CBμE. We anticipate that this low cost and non-invasive electrochemical sensing technology could enable rapid detection at POC and may facilitate fast personalized health care delivery.



Dr. Khan received his PhD degree in Electrical Engineering with emphasis on Bionanotechnology in Dec 2015 from University of Alabama in Huntsville, AL USA. He has keen interest to deliver efficient and reliable solution to health care providers at the minimal cost. His research interests are mainly focused on Point-of-Care health diagnostics using electrochemical biosensors, microfluidics devices, BioMEMS chips for smart and connected health care.

Development of Disposable Ocular Biosensor for Real Time Detection of Ascorbic Acid in Tear Film and Aqueous Humor

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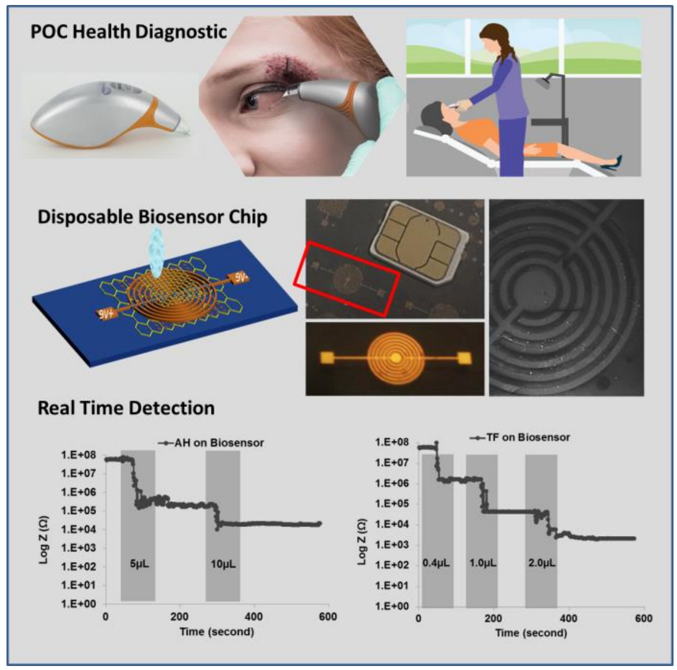
Current methods for evaluating bleb-leaks, the integrity of the anterior globe in trauma patients and the wound integrity in post-operative patients involve the use of a high concentration of fluorescein dye into the ocular tear film (TF) and then observing for a change in the color of the dye. This change in color would indicate the passage of aqueous humor (AH) through a corneal or anterior scleral wound, which represents a direct communication of the internal eye fluid with the external TF. However, this technique called a Seidel Test is subjective and not standardized. At present, there are no FDA approved ocular biosensor device that can directly estimate ascorbic acid (AA) concentration levels in TR at point-of-care (POC) level. Herein, we propose a novel quantitative assay, called the Ocular Biosensor, which can be used to evaluate the integrity of the anterior surface of the eye by detecting the real time concentration of AA presence in both the TF and the AH. Filter paper was initially spin coated with poly(styrene)-block-poly(acrylic acid) (PS-*b*-PAA) and graphene nanoplatelets to establish a thin uniform composite (GP). Finally, contour based micro-electrodes design (CBμE) was fabricated at Micro-Nanotechnology Laboratory (MNTL, UIUC) on GP which exhibits a highly sensitive platform to perform electrochemical immunosensing technique. Biosensor chip has been tested successfully to study clinically collected samples (TF and AH) from patients undergoing therapeutic anterior chamber paracentesis at Eye Clinic of Carle Foundation Hospital. This disposable POC biosensor device can have several inherent advantages, including on-chip sample preparation, label-free detection, reduced cost and complexity, decreased sample volume in case of TF, increased portability, and large-scale multiplexing.



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Simulation Training for Mechanical Circulatory Support using Extra-Corporeal Membrane Oxygenation (ECMO) in Adult Patients

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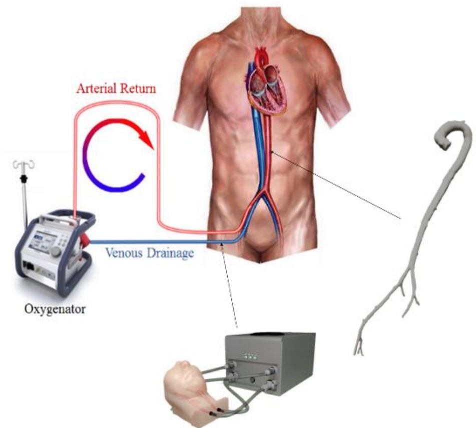
In this project, we are developing and validating a system of simulation that will aid in the quick deployment of acute mechanical support of the failing heart and/or lungs. Typically, this is achieved by a technique called Extra-Corporeal Membrane Oxygenation (ECMO), which utilizes one large tube in the venous system of the body draining the blood and another large bore tube or cannula returning blood into the arterial system of the blood at a certain pressure. Simulation systems of great sophistication have been built and used in a variety of task training modes in medicine. However, there is a deficiency in the area of deployment of these large bore cannulae or access tubes in sick patients.



We are replicating the basic steps from vascular access to cannulation and connection to ECMO. This will help to simulate commonly encountered complications and problems which include peripheral arterial and venous access, often in a critically ill or unstable patient. A mannequin with embedded 3D printed vasculature that will be amenable to access, wire deployment and over the wire delivery of percutaneous cannulae is used. The system is being made to replicate common clinical conditions such as difficult access, extreme hemodynamic instability, hypoxemia, and common complications, while providing realistic immersive experiences such as pulsations and “blood” flow in the underlying vessels. This is carried with the help of DR Doppler, a blood flow simulator.

Pramod Chembrammel is a Research Scientist at Health Care Engineering Systems Center at the University of Illinois at Urbana-Champaign. He received his doctoral degree from State University of New York at Buffalo in 2015. His research interests are neuro-robotics, multibody dynamics, physics based medical simulations and imitation learning by robots.

Positive User Experience in Assistive Devices for People with Disabilities: A Case Study of a Personal Voice Amplifier

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Rachel Graddy, Deana McDonagh, Skot Weidmann, Alexis Wernsing

While an assistive device may check all the boxes for functional specifications, it may still produce a negative user experience. As our technological capabilities evolve, new types of devices are being created to assist people with disabilities. It is important to consider a positive user experience as a requirement for assistive products. A case study is presented for a voice amplification device, intended primarily for users with diminished vocal capacity due to Cerebral Palsy, where functional needs would appear to be met by existing products on the market. However, available devices can make people feel self conscious and uncomfortable for several reasons. These factors include an inability to operate the device independently; awkward location of the device on the body or power chair; interference with other assistive devices such as headrests or power chair controls; conspicuousness of devices that draw attention away from the person while they are speaking; and an inability to choose a personal aesthetic for objects that are attached to the body. Empathic human-centered research methods can uncover hidden trouble points for users and allow for more effective and pleasing assistive devices for users.

Rachel Heaton is a third year MFA candidate (2017), Industrial Design in the School of Art + Design at the University of Illinois at Urbana-Champaign. She is an experienced Integrated Circuit Logic Design Engineer who worked on CPU and network processors at IBM and LSI corporations. She recently worked as a User Experience Researcher and User Interface Designer on Internet of Things (IoT) mobile applications at John Deere Technology Innovation Center in the University of Illinois Research Park. Her research centers on the role of aesthetics in user experience and related personal sustainability decisions. As an engineer and a designer, she is involved in campus efforts to bring design development methodologies to engineering practice, helping to develop courses to bring Design Thinking principles to Engineering students within the department of Mechanical Science and Engineering and Computer Science. Deana McDonagh, Skot Weidmann, and Alexis Wernsing conceived of the AmpliMy Project in order to assist students with vocal disabilities in the educational environment. Rachel Graddy acts as a contributing project consultant.

Prototyping a Quasi Four Dimensional Drug-eluting Stent for Personalized Management of Arterial Plaques

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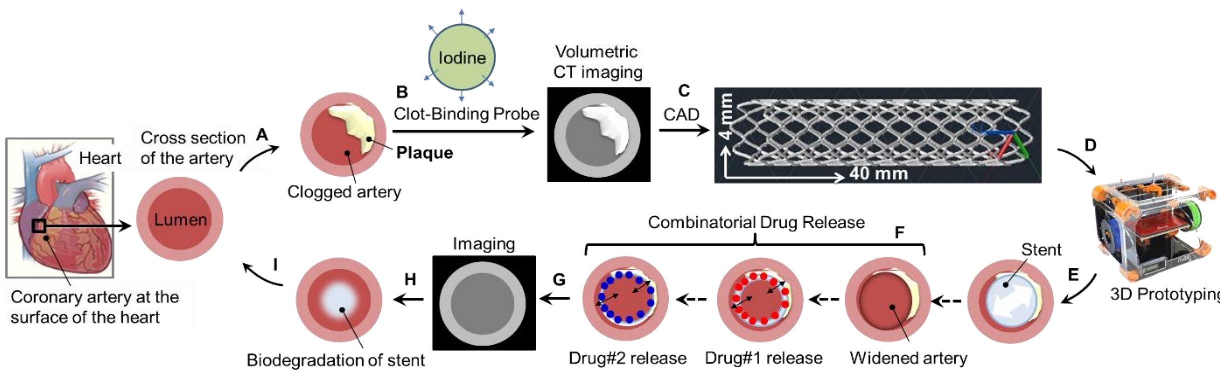
Patients with percutaneous coronary intervention (PCI) generally receive either bare metal stents (BMS) or drug-eluting stents (DES) to restore the normal blood flow. However, due to the lack of stent production with an individual patient in mind, the same level of effectiveness might not be possible in treating two different clinical scenarios.



We introduce for the first time the feasibility of a patient-specific stenting process constructed from direct 3D segmentation of medical images (Figure shows strategy of stent production and application). A biodegradable polymer-carbon composite is prepared doped with graphene nanoplatelets to achieve controlled release of combinatorics as anti-coagulation and anti-restenosis agents. Our approach exploits novel self-expanding biodegradable polymer composites in pseudo fourth dimension (4D) and unites with the emerging field of personalized prototyping. We developed a technology prototyped for personalized stenting. An in-silico analysis was performed to optimize the stent design for printing and its prediction of sustainability under force exerted by coronary artery or blood flow. A holistic approach covering in silico to in situ-in vivo established the structural integrity of the polymer composite, it's mechanical properties, drug loading and release control, functional activity, safety and feasibility of placement in coronary artery of swine. Thus, we developed a methodology for prototyping a 'quasi' fourth dimensional drug-eluting stent for personalized management of arterial plaques.

Santosh K. Misra, is a research scientist in MatMed lab of department of Bioengineering at the University of Illinois at Urbana-Champaign. He is currently working with Prof. Dipanjan Pan. He has been guest lecturer for BioE students, co-investigator for high value research grants, post-doctoral researcher, research consultant for start-up company, peer reviewer for some major scientific journals including nature publishing group journal and project mentor for many under graduate and graduate students. He is co-inventor of biomedical products and also involved in clinical trials. He received his B.Sc. in Biological sciences from DDU, India in 2002 and M.Sc. in organic chemistry from LU, India in 2005. He was awarded with CSIR-NET eligibility in 2006 and 2007. He gained his doctorate from the Dept. of Organic Chemistry at Indian Institute of Science in 2013 under guidance of Prof. Santanu Bhattacharya. He was awarded with prestigious "Guha Research Medal" for his Ph.D. research work.

Robust Interactive visualization platform for the screening and monitoring of behavior

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Activity sensors such as Fitbit have become increasingly popular and many have explored how they can be utilized to for healthcare applications such as rehabilitation and screening for behavioral disorder. Most of these sensors, however, often come with simple interfaces that only show general statistics such as number of steps taken, heartbeats, etc. These simple statistics are often not sufficient for patients to understand what they should do to improve their conditions, and healthcare practitioners may need more information to do screening or monitoring. The proposed platform will utilize data science techniques to generate customized behavioral guidance for patients. The guidance will, for example, better communicate risk information (e.g., Of 100 patients who have an activity profile like you, 35 have improved their condition by walking 2 more flights of stairs each day), allow better visualization that highlight more relevant data for screening or diagnosis (e.g., The reason we recommend that you perform further testing is that your heart rate remains high 30 minutes after exercise), and convert qualitative data into qualitative terms in ways that are more easily understandable to the patients. The platform will also allow healthcare practitioners to provide input to the data analysis process, such that both top-down and bottom-up data analytics can be generated to facilitate communication between patients and practitioners.

Wai-Tat Fu is an associate professor of computer science at the University of Illinois at Urbana-Champaign. Wai-Tat's research focuses on human-computer interaction, especially on intelligent user interfaces and healthcare informatics. He is the general chair of the 2016 IEEE International Conference on Healthcare Informatics (ICHI), the premier conference on information technologies applied to healthcare domains. He is also the program chair of the ACM conference on Intelligent User Interfaces (IUI), the major conference on intelligent interfaces. He is also the associate editor of the journal ACM Transactions on Intelligent Interactive Systems.

Audio-Visual Emotive Avatar with Application to Doctor-Patient Interaction

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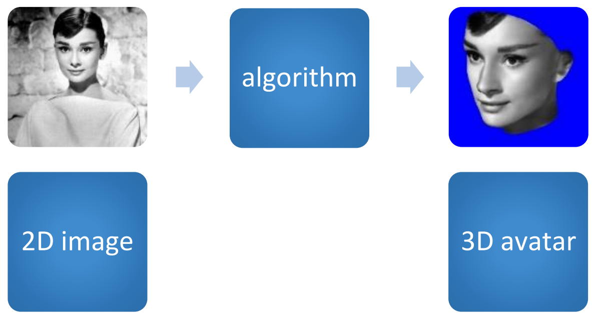

The Personal Health Record Systems (PHRs) has been listed as a top priority by the US government and many patients have a positive attitude toward such systems. However, most PHRs are underutilized, where the most important reason is that many patients lack the technical knowledge to understand the message and results delivered by the portal system. To improve the usability of PHRs, we propose to integrate 3D avatars into traditional portal systems as a way to assist patients toward a better understanding of portal messages, and to increase the effectiveness of PHRs as a communication tool between patients and their clinical care providers.

The proposed avatar system takes a 2D frontal face image and medical results in the form of plain text as input, and generates an audio-visual emotive avatar (namely a "talking head"), which is capable of speaking the text script in different emotions. Both the emotion of the sound and the facial expression can be specified by the emotion markers to match the context. Currently the avatar is not interactive, which merely reads the medical results. In the future, interactions can be added to make the avatar more user friendly and responsive. The next step will be to further improve the visual and audio performance as well as exploring the Uncanny-Valley phenomenon in a medical, physician-patient communication scenario.

Kuangxiao Gu received his Bachelor degree in Electrical Engineering from University of Illinois Urbana Champaign. He is currently in Graduate School with a focus on computer vision, supervised by Professor Thomas S. Huang. He works on the visual synthesis part of the avatar system in this project.

Kaizhi Qian and **Yang Zhang** are both graduate students in Electrical Engineering from UIUC focusing on speech processing, supervised by Professor Mark Hasegawa-Johnson. They focus on the audio synthesis of the avatar system.

Jump Trading Simulation & Education Center

Health Care Engineering Systems Center