Fresh Tracks

News from the Scientific Computing and Imaging Institute

January 2013

In this issue

www.sci.utah.edu

Message from the Director

Welcome to the first Fresh Tracks Newsletter, highlighting news from the SCI Institute. 2012 was another exciting year, culminating in our second successful SCIx Open House. Hundreds of people took advantage of the event to learn more about SCI Institute research and hear SCIx keynote speaker Alan Kay, a Turing Award recipient give an enlightening and entertaining presentation.

SCI Institute faculty garnered a number of prestigious research awards in 2012. Jeff Weiss received the Van Mow Medal, Miriah Meyer was named a Microsoft Faculty Fellow and a TED Fellow, Chuck Hansen was elected as an IEEE Fellow, and Valerio Pascucci was inducted as a DOE Fellow. Tolga Tasdizen received an NSF CAREER Award and the College of Engineering Distinguished Teaching Award. I was honored to receive the 2012 IEEE IPDPS Charles Babbage Award.

In this issue, we highlight a research collaboration between our NIH Center for Integrative Biomedical Computing (CIBC) and Dr. Christopher Butson of the University of Wisconsin. This collaboration emphasizes computational modeling, simulation and visualization of deep brain stimulation (DBS) planning, a therapy used in the treatment of movement disorders such as Parkinson's. Optimization of DBS electrodes is accomplished using our ImageVis3D Mobile software on an iPad.

In 2013, we welcome Dongbin Xiu as the 15th tenure-track faculty member within the SCI Institute. Dongbin, a Professor of Mathematics, is one of the most recognized names and highly cited researchers in the area of uncertainty quantification.

We hope you will join us for the 2013 SCI Institute Distinguished Lecture Series,on Fridays at 2:00 p.m. in the Evans Conference Room. If you can't attend, these Distinguished Lectures are available on the SCI TV section of our website. Details of all our upcoming seminars and lectures, along with an archive of previous seminars are available at:

http://www.sci.utah.edu/the-institute/events.html.

Sincerely,
Chris R. Johnson, Ph.D.
Director,
Scientific Computing and Imaging (SCI) Institute
Distinguished Professor,
School of Computing
University of Utah

SCI Events

Valerio Pascucci demonstrates the ViSUS suite of tools to this year's SCIx keynote speaker, Alan Kay.

SCIX 2012

This year's SCIx featured cutting-edge work from the SCI Institute, culminating in a keynote presentation from Turing Award recipient Alan Kay. If you missed this event, the SCIx website (www.sci.utah.edu/scix) highlights computing techniques and tools created by SCI researchers and collaborators as they work to solve important problems to humankind through image analysis, scientific computing, and visualization research.

Miriah Meyer Gould Lecture

Miriah Meyer, assistant professor in the School of Computing, presented the University of Utah's William R. & Erlyn J. Gould Lecture on Technology and the Quality of Life, titled "Visualizing Data: Why an (interactive) Picture Is Worth 1000 Numbers."

Art of Science - Park City

Leonardo Da Vinci said "Study the science of art and the art of science." As internationally recognized leaders in scientific visualization, researchers at the SCI Institute develop new and better ways to visualize and communicate the results of scientific inquiry. We believe visual design and composition are important in creating effective scientific visualizations. In fact, artists have known for millennia that humans respond very powerfully to visual stimuli, suggesting visual beauty is an effective means for communicating important scientific information. Whether in visualizations of computer simulations in combustion or bioelectric activity in the heart and brain, or of data ranging from a galactic scale down to the cellular level, and sometimes images created to serve science can rise to the level of art. SCI images have recently been on exhibit at the Salt Lake City Library, the Kimball Art Center in Park City and the Utah Cultural Celebration Center.

Awards and Acknowledgements

Jeff Weiss received the 2013 Van Mow Medal from the American Society of Mechanical Engineers (ASME). This highly competitive award is ASME's highest honor for a mid-career bioengineer. Jeff was chosen "for seminal contributions to research in biomechanics related to fundamental structure-function relationships in musculoskeletal soft tissues, subject-specific modeling of joint mechanics, image-based biomechanics, the mechanics of angiogenesis, and the development and distribution of the FEBio software suite.

Chris Johnson received the IEEE IPDPS 2012 Charles Babbage Award in recognition of his innovations in the area of scientific visualization and their application to computational biomedicine, engineering and scientific discovery. www.sci.utah.edu/images/stories/2012/CRJ_BabbageAward2012.pdf.

Miriah Meyer was selected as one of seven Microsoft Research Faculty Fellows for 2012. The award recognizes innovative, promising new faculty members for their advancements in computing research. She has also been selected as a 2013 TED Fellow.

Tolga Tasdizen received a CAREER award from the National Science Foundation for his proposal "Deep sparse dictionary context models and their application to image parsing and neuron tracking for connectomics." Dr. Tasdizen was also recently recognized by the University's College of Engineering with the 2012 Distinguished Teaching Award.

Chuck Hansen has been elected an IEEE Fellow in recognition of his extraordinary accomplishments in the development of visualization tools for large-scale scientific datasets.

Valerio Pascucci has been recognized as a Department of Energy (DOE) Fellow, the top scientific achievement designation within DOE recognizing an individual's outstanding contributions to the scientific and engineering community. Dr. Pascucci received this honor at Pacific Northwest National Laboratory where he is a member of the Scientific Data Management Group.

Best Paper Awards

S. Liu, J.A. Levine, P.-T. Bremer, V. Pascucci. "Gaussian Mixture Model Based Volume Visualization," Proceedings of the IEEE Symposium on Large-Scale Data Analysis and Visualization (LDAV) 2012. "Best Paper" at the IEEE Symposium on Large-Scale Data Analysis and Visualization (LDAV) 2012

S.P. Awate, P. Zhu, R.T. Whitaker. "How Many Templates Does It Take for a Good Segmentation? Error Analysis in Multiatlas Segmentation as a Function of Database Size," In Int. Workshop Multimodal Brain Image Analysis (MBIA) at Int. Conf. MICCAI, Lecture Notes in Computer Science (LNCS), Vol. 2, pp. 103--114. 2012. "Best Paper" at the MICCAI workshop on Multimodal Brain Image Analysis.

P.H. Gesteland, Y. Livnat, N. Galli, M.H. Samore, A.V. Gundlapalli. "The EpiCanvas infectious disease weather map: an interactive visual exploration of temporal and spatial correlations," In Journal of the American Medical Informatics Association, Vol. 19, pp. 954--959. 2012. Awarded the Homer R. Warner Award at the AMIA Annual Symposium and the 1st place for Outstanding Research Article at ISDS 2012.

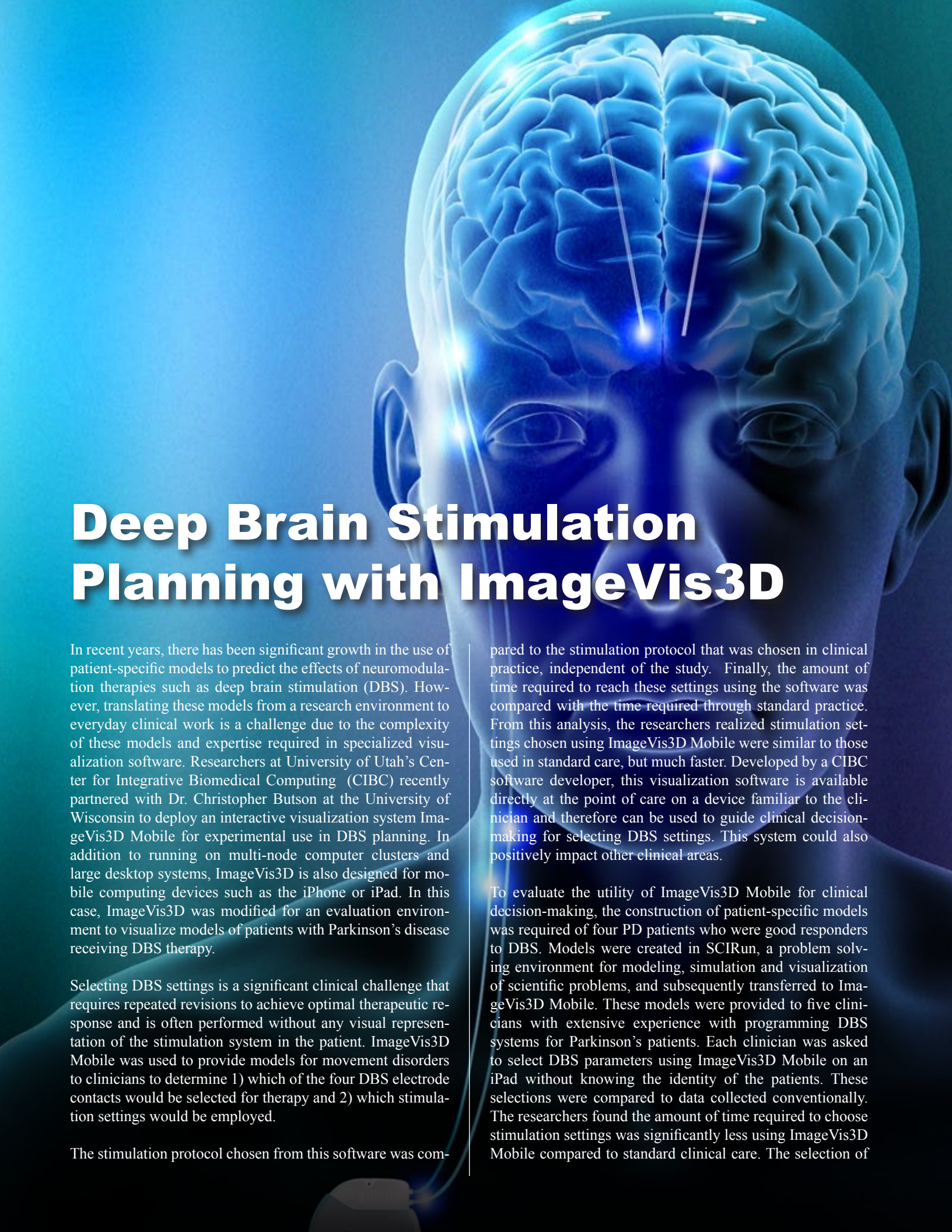
J.J. Wolff, H. Gu, G. Gerig, J.T. Elison, M. Styner, S. Gouttard, K.N. Botteron, S.R. Dager, G. Dawson, A.M. Estes, A. Evans, H.C. Hazlett, P. Kostopoulos, R.C. McKinstry, S.J. Paterson, R.T. Schultz, L. Zwaigenbaum, J. Piven. "Differences in White Matter Fiber Tract Development Present from 6 to 24 Months in Infants with Autism," In American Journal of Psychiatry (AJP), Note: Selected as an AJP Best of 2012 paper., pp. 1--12. 2012.

In the News

U of U aims to lighten soldiers' load with better batteries
– ksl.com

U. professor helping scientists see their work in a different way
– Deseret News

Utah Image Processing Group Plays Key Role in Autism Research
– ScienceDaily



Deep Brain Stimulation Planning with ImageVis3D

In recent years, there has been significant growth in the use of patient-specific models to predict the effects of neuromodulation therapies such as deep brain stimulation (DBS). However, translating these models from a research environment to everyday clinical work is a challenge due to the complexity of these models and expertise required in specialized visualization software. Researchers at University of Utah's Center for Integrative Biomedical Computing (CIBC) recently partnered with Dr. Christopher Butson at the University of Wisconsin to deploy an interactive visualization system ImageVis3D Mobile for experimental use in DBS planning. In addition to running on multi-node computer clusters and large desktop systems, ImageVis3D is also designed for mobile computing devices such as the iPhone or iPad. In this case, ImageVis3D was modified for an evaluation environment to visualize models of patients with Parkinson's disease receiving DBS therapy.

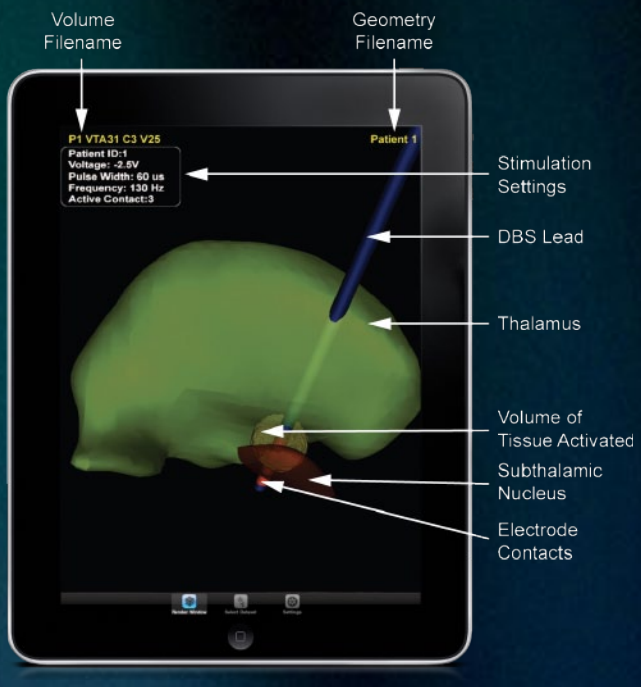
Selecting DBS settings is a significant clinical challenge that requires repeated revisions to achieve optimal therapeutic response and is often performed without any visual representation of the stimulation system in the patient. ImageVis3D Mobile was used to provide models for movement disorders to clinicians to determine 1) which of the four DBS electrode contacts would be selected for therapy and 2) which stimulation settings would be employed.

The stimulation protocol chosen from this software was compared to the stimulation protocol that was chosen in clinical practice, independent of the study. Finally, the amount of time required to reach these settings using the software was compared with the time required through standard practice. From this analysis, the researchers realized stimulation settings chosen using ImageVis3D Mobile were similar to those used in standard care, but much faster. Developed by a CIBC software developer, this visualization software is available directly at the point of care on a device familiar to the clinician and therefore can be used to guide clinical decision-making for selecting DBS settings. This system could also positively impact other clinical areas.

To evaluate the utility of ImageVis3D Mobile for clinical decision-making, the construction of patient-specific models was required of four PD patients who were good responders to DBS. Models were created in SCIRun, a problem solving environment for modeling, simulation and visualization of scientific problems, and subsequently transferred to ImageVis3D Mobile. These models were provided to five clinicians with extensive experience with programming DBS systems for Parkinson's patients. Each clinician was asked to select DBS parameters using ImageVis3D Mobile on an iPad without knowing the identity of the patients. These selections were compared to data collected conventionally. The researchers found the amount of time required to choose stimulation settings was significantly less using ImageVis3D Mobile compared to standard clinical care. The selection of

stimulation settings required an average of 1.7 +/- 0.8 minutes per patient across all clinicians, compared to an average of 4 +/- 1.4 hours required for programming via standard care to reach stable settings with good therapeutic response (usually within three to four clinic visits).

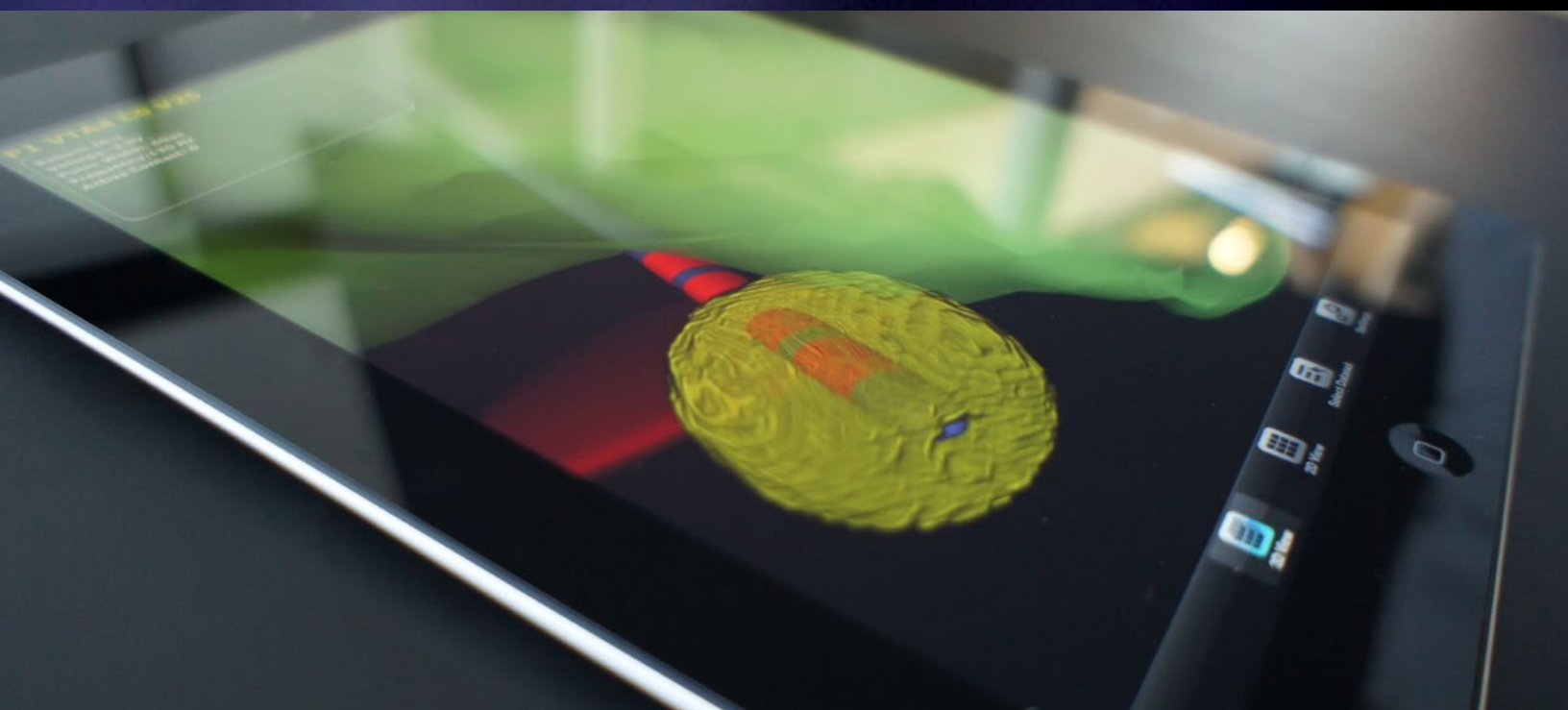
Active electrode contacts chosen using ImageVis3D Mobile were either the same as or adjacent to the contact chosen using standard care. Prior studies have noted comparable therapeutic benefits from more than one electrode contact. Hence, the degree of variability is considered within the range observed clinically.



Furthermore, clinician feedback on this system was very positive. The user interface is intuitive, especially for those users already familiar with the iPhone. The ability to interactively visualize patient models provides a level of understanding not currently available. Clinicians using this system are optimistic about its long-range potential to provide an optimal DBS therapy more rapidly than previously possible. The salient features for clinical decision-making are: easily retrieve data; view the DBS electrode location relative to surrounding anatomy on an individual patient basis at the point of care; view how DBS-induced volumes of tissue activated overlap with nearby anatomical structures; and to interact with the visualization with an intuitive touchscreen interface.

This system could provide a significant step forward in clinical practice for several reasons. Mobile computing platforms such as the iPhone are widely used by physicians, and new hardware devices such as the iPad have generated significant interest in the clinical community. Computational models are gaining acceptance and are being used more often by practitioners for clinical decision-making. The system described here has a simple, intuitive interface that can be used at the patient's bedside.

In this study, the interactive visualization provided a structure for comparing different approaches to DBS programming. A persistent problem in neuromodulation is the vocabulary for describing target locations is somewhat imprecise, and different practitioners employ alternative programming approaches. While previous attempts have been made to provide interactive visualization of patient-specific DBS models, these require significant amounts of training and domain knowledge to gain proficiency. An advantage of the system developed at the CIBC is the minimal amount of training required and its attractive features for clinical workflow. This approach could have a significant impact not only in DBS for Parkinson's, but also in other neuromodulation methods in which interactive patient-specific models could provide useful insights into the best way to prescribe the therapy. The use of patient-specific models of DBS in a mobile computing device running ImageVis3D Mobile has strong potential to improve patient outcomes by facilitating clinical decision-making.



Student Internships

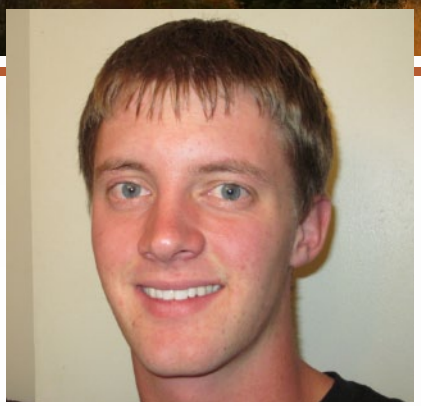
Neda Sadeghi
Pierre Lassonde
New Venture Development Center

"I joined the Lassonde program to learn more about how to take a product or a service to market. We are doing fascinating research at SCI and I hope to be able to transfer what I learn here to the business world. As a graduate student who does research in early brain development, I would like to continue research in my field, but I would love to see clinicians using the methodologies that we develop. At the Lassonde program, we learn more about what makes a product or a service successful, how to do market research and if development of a product is feasible."

The Pierre Lassonde Center

Brett Burton
Pierre Lassonde
New Venture Development Center

"During my first year with the Lassonde Center, I chose to work on a technology closely aligned with my interests and research. Our team developed a business plan while experiencing a "roller coaster": the high expectations around a technology that we felt could revolutionize healthcare; the realization that acceptance in the medical community is an extremely high hurdle; the fear of potential intellectual property violations, insurance rejection, and FDA roadblocks; the potential interest of a huge market; and the financial benefit to patient, doctor, hospital, and the business community if we were to succeed. This experience was so eye-opening that I decided to stay on as an associate student director at the Lassonde Center assisting teams going through this same "roller coaster" process. Overall, my experience with the Lassonde Center has been challenging, educational, enjoyable and rewarding. I have presented in front of panels of judges, angel investors, venture capitalists, industry leaders, university boosters and academic advisory boards while balancing a busy research schedule. I have become more efficient with my time, more experienced in business, more connected around the valley, and more informed when deciding - Industry or Academia?"



Caleb Rottman
GE Healthcare

"This past summer, after my second year of graduate school with Professors Joshi and Whitaker, I did an internship with GE Healthcare Surgery in Salt Lake City. I benefited from the long-standing relationship between GE Healthcare and the SCI Institute. GE Healthcare Surgery specializes in the design and manufacturing of mobile fluoroscopic C-arms, which are used to create X-ray video sequences that physician use during major surgical procedures. We were tasked to find ways to decrease the amount of X-ray radiation that patients receive during surgery to increase safety while maintaining the high image quality. This internship required me to attend GE classes about the sales and clinical aspects of the business, where I became aware of the challenges and expectations of clinical experts including physicians and C-arm technicians. I received hands-on experience using C-arms and I used this knowledge to acquire test data. The best part of my GE internship experience was that it expanded my view of where my research fits in the big picture for GE Healthcare."

Alumni Highlights

David DeMarle
M.S. in Computer Science, '09
Research and Development Engineer, Kitware

David received a M.S. in computer science from the University of Utah in 2003, with thesis work on the design and use of a distributed shared memory system to render data sets that require the aggregate physical memory space of a cluster.

As a teaching assistant in Ross Whitaker's scientific visualization course and while doing his research into parallel rendering with Chuck Hansen and Steve Parker, David honed the skills needed to perform his current role.

David joined Kitware as a Research and Development Engineer in June of 2005. He primarily contributes to expand the capabilities of ParaView and VTK, open-source scientific visualization tools used by thousands of researchers around the world and integrated into many scientific applications. David's secondary responsibilities at Kitware include support for its large user and developer communities, for which he answers questions on VTK and ParaView mailing lists and teaches courses about Kitware's tools at conferences around the world.

Find out more about David and other SCI Alumni:
www.sci.utah.edu/people/alumni

Ruth Klepfer
Ph.D. in Bioengineering, '97
Principal Scientist at Medtronic

For the last twelve years, Dr. Klepfer has been a scientist at Medtronic focusing on potential therapies and diagnostics for people with congestive heart failure. She is responsible for study design, protocol development, conduction of studies (both animal and clinical) and data analysis and interpretation. She also performs consulting work and collaborates on research studies with physicians...

Ruth received her Ph.D. in bioengineering from the University of Utah in 1997. At the SCI Institute, Dr. Klepfer worked with Drs. Chris Johnson and Rob Macleod and constructed a computer model of the macroscopic electrophysiology of the heart and torso using the finite element method.

Find out more about Ruth and other SCI Alumni:
www.sci.utah.edu/people/alumni

2012 SCI Distinguished Lectures

Fran Berman: Got Data? Building a Sustainable Digital Environment for Innovation in the Information Age

Mary Czerwinski: Emotion Tracking for Memory, Health and Awareness

Scott Delp: Insights from simulating gait dynamics and disorders

Jack Dongarra: On the Future of High Performance Computing: How to Think for Peta and Exascale Computing

Gene Myers: On Bioimage Informatics and Decoding Genomes

Heinz-Otto Peitgen: Medical Image Computing and Liver Surgery Planning

Catherine Plaisant: Interactive Visualizations of Temporal Event Sequences (with a focus on Electronic Health Record data)

Daniel Rueckert: Machine learning meets medical imaging: From signals to clinically useful information

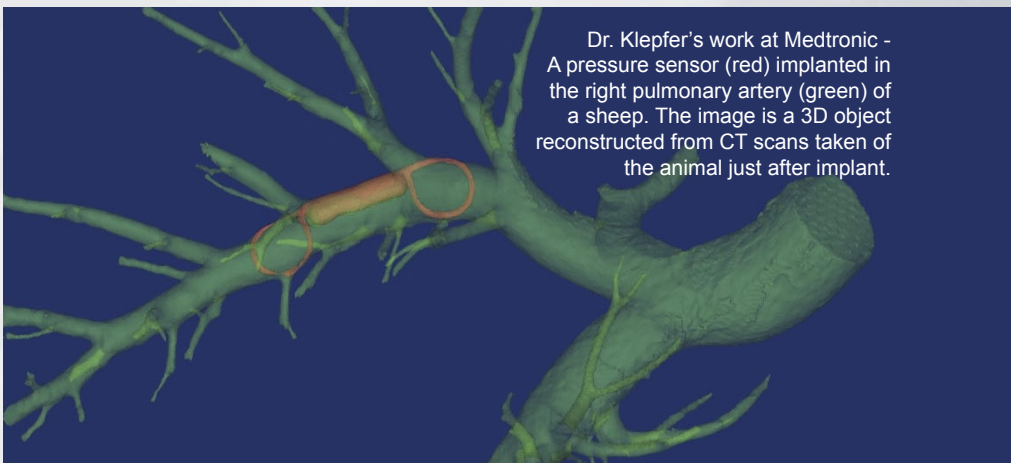
Ben Santer: A Life in Climate Science: From Identification of a "Discernible Human Influence" on Climate to Identification of the "Top Ten" Climate Models

Stephen Smith: The Synaptome Meets the Connectome: Fathoming the Deep Diversity of CNS Synapses

Coming in 2013

Jan 25	Michael Goodchild
Feb 15	Tamara Munzner
Mar 8	James Ferrell
Apr 12	Alfio Quarteroni
Apr 19	George Spirou
Oct 11	Matthew Scott

You can find all SCI Events at:
www.sci.utah.edu/the-institute/events



Dr. Klepfer's work at Medtronic - A pressure sensor (red) implanted in the right pulmonary artery (green) of a sheep. The image is a 3D object reconstructed from CT scans taken of the animal just after implant.

New Faces at SCI

Dr. Dongbin Xiu
Dongbin Xiu has Joined the SCI Institute as a Professor of Mathematics

Dongbin is one of the most recognized names and frequently cited researchers in the area of uncertainty quantification and is the founding Associate Editor for the International Journal for Uncertainty Quantification. Dongbin received his Ph.D from the Division of Applied Mathematics at Brown University in 2004 and conducted post doctoral studies at Los Alamos National Laboratory, Princeton University and Brown University. In the fall of 2005 Dongbin joined the Department of Mathematics at Purdue University, becoming Full Professor in 2012. Dongbin's research focuses on developing efficient numerical algorithms for stochastic computations and uncertainty quantification. He serves on the editorial boards of Applied Numerical Mathematics, SIAM Review and SIAM Journal on Scientific Computing, among others. Dongbin received an NSF CAREER award in 2007 and numerous teaching awards at Purdue. His research is funded by AFOSR, DOE, NNSA, and NSF.

New SCI Staff and Students in 2012

James Hughes
Computer Professional
CIBC Developer / ImageVis3D

Mavin Martin
Computer Technician
SCI IT Team

Clement Vachet
Project Administrator
Dr. Gerig / Neuroimaging

Shankar Sastry
Post Doctoral Fellow
Dr. Whitaker / Meshing

Avishek Saha
Post Doctoral Fellow
Dr Pascucci / High-dimensional Data Analysis

Christopher Gritton
Graduate Research Assistant
Dr. Berzins / Material Point Method

Yichen Zhou
Graduate Research Assistant
Dr. Kirby / Scientific Computing

Atul Rungta
Graduate Research Assistant
Dr. Pascucci / Scientific Visualization

Katie Aiello
Graduate Research Assistant
Dr. Alter / Computational Systems Biology

Pascal Grosset
Graduate Research Assistant
Dr. Hansen / Volume Rendering

Sean Patrick McKenna
Graduate Research Assistant
Dr. Meyer / Information Visualization

Philip Samuel Quinan
Graduate Research Assistant
Dr. Meyer / Uncertainty Visualization

Amit Roy
Graduate Research Assistant
Dr. Kirby / Scientific Computing

Medhi Sajjadi
Graduate Research Assistant
Dr. Tasdizen / Connectome Reconstruction

Theodore Schomay
Graduate Research Assistant
Dr. Alter / Computational Systems Biology

Ariel Herbert-Voss
Research Assistant
Dr. Johnson / Uncertainty Visualization

Florian Rousset
Research Assistant
Dr. Gerig / Neuroimaging

Zella Urquhart
Research Assistant
Dr. Meyer / Computer Science

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