Utah NIH P41 EAB Meeting 2012

Introduction

The NIH/NCRR Center for Integrative Biomedical Computing
The Center for Integrative Biomedical Computing (CIBC) is dedicated to producing open-source software tools for biomedical image-based modeling, biomechanical simulation and estimation, and the visualization of biomedical data. The Center works closely with software users and collaborators in a range of scientific domains to produce user-optimized tools and provides advice, technical support, workshops, and education to enhance user success. Biological projects and collaborations drive our development efforts, all with a single unifying vision: to develop the role of image-based modeling and analysis in biomedical science and clinical practice.

Research Highlights:

- Imaging meets Electrophysiology
  Helping People with Heart Troubles

More CIBC highlights
<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Presenter(s)</th>
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Center History

Center for Bioelectric Field Modeling, Simulation and Visualization established in 1999.
Renewed as the Center for Integrative Biomedical Computing (CIBC) established in October 2005.
Submitted Renewal in September 2009 (end date is July 31, 2010)
Renewed until July 31, 2015 – Yeah!!
Center Moves to NIGMS in 2012
New Program Officer – Fred Friedman
CIBC Personnel Changes

Departed:
Michael Steffen, Ph.D. – Boeing, Seattle
Tom Fogal, M.S. – Ph.D. Student, Univ. of Saarbrucken, Summers at SCI
Josh Levine, Ph.D. – TBA

Joined:
Liz Jurrus, Ph.D. – Technical Manager
Erik Anderson, Ph.D. – Visualization Postdoc (half time)
James Hughes, B.S. – Software Developer
Dan White, M.S. – Software Developer

Special Mention:
Ayla Khan – Leader of CIBC Software Effort
Jens Krueger – Spending one month a year at SCI
Introduction

Center Vision
Image-Based Modeling, Simulation, and Visualization

- Image & Data Acquisition
- Image Processing
- Integrated Software Tools
- Geometry Processing
- Lab/Clinic
- Visualization
- Modeling, Simulation & Validation
Center Strategy

Introduction
Continued Center Impact

NIH/NCRR Center
Awarded for 3 years.
Sept, 1999

46 Publications
First Workshop
map3d v3.0 - 6.2
BioPSE/SCI Run v1.0.0 - v1.6.0

NIH/NCRR Center
Renewal for 3 years.
Sept, 2002

49 Publications
Second Workshop
map3d v6.4 - 6.5
BioPSE/SCI Run v1.20.0
First release:
BioFEM
BioTensor
BioImage

NIH/NCRR CIBC
Renewal for 5 years
Feb. 2005

157 Publications
5 Workshops
BioPSE/SCI Run v1.20.0 - v4.2
BioFEM
BioTensor
BioImage
New BioMesh3D
ImageVis3D v1.0
Seg3D v1.12
ShapeWorks

NIH/NCRR CIBC
Renewal for 5 years,
July 2010

44 Publications
1 Workshop
BioPSE/SCI Run v4.2 - v5.0
BioFEM
BioTensor
BioImage
BioMesh3D
BioMesh3D Client v1.0
ImageVis3D v2.0.1
Seg3D v2.14
ShapeWorks v0.3.0

2015

Now
Center Software Infrastructure

ImageVis3D is a new volume rendering program developed by the NIH/NCCR Center for Integrative Biomedical Computing (CIBC). The main design goals of ImageVis3D are: simplicity, scalability, and interactivity. Simplicity is achieved with a new user interface that gives an unprecedented level of flexibility (as shown in the images). Scalability and interactivity for ImageVis3D mean that both on a notebook computer as well as on a high end graphics workstation, the user can interactively explore terabyte sized data sets. Finally, the open source nature as well as the strict component-by-component design allow developers not only to extend ImageVis3D itself but also reuse parts of it, such as the rendering core. This rendering core for instance is planned to replace the volume rendering subsystems in many applications at the SCI Institute and with our collaborators.

Scientific Software Solutions

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Center for Integrative Biomedical Computing
72 S Central Campus Drive
Salt Lake City, UT 84112
Phone: 801-585-1867

Chris Johnson - PI, Director - cj@sci.utah.edu
Rob McLeod - PI, Co-Director - macleod@sci.utah.edu
Ross Whitaker - PI - whitaker@sci.utah.edu
Dana Brooks - PI - brooks@ece.neu.edu
Greg Jones - Executive Administrator - greg@sci.utah.edu
Elizabeth Jarrus - Technical Manager - liz@sci.utah.edu

development distribution training
Center Software Infrastructure

SCIRun is a modular dataflow programming Problem Solving Environment (PSE). SCIRun has a set of modules that perform specific functions on a data stream. Each module reads data from its input ports, calculates the data, and sends new data from output ports.

BioMesh3D is a tetrahedral mesh generator for multi-material quality meshes out of segmented biomedical image data. The BioMesh3D program uses a particle system to distribute nodes on the separating surfaces that separate the different materials and then uses the TetGen software package to generate a full tetrahedral mesh. A client-server interface is available to guide the user through the process of building a mesh. Because building a high quality mesh often requires a lot of computation, this application allows the user to connect to the SCI facility servers for computing their meshes.

Seg3D2 is a recent redesigned volume segmentation and processing tool that combines a flexible manual segmentation interface with powerful higher-dimensional image processing and segmentation algorithms from the Insight Toolkit. Users can easily explore and label image volumes using volume rendering and orthogonal slice view windows.

The ShapeWorks software makes available a method for constructing compact statistical point-based models of ensembles of similar shapes that does not rely on any specific surface parameterization. The method requires very little preprocessing or parameter tuning, and is applicable to a wide range of shape analysis problems, including nonmanifold surfaces and objects of arbitrary topology. Tools are available for preprocessing data, computing pointbased shape models, and visualizing the results.
CIBC Software Downloads – March 2012

SCIRun/BioPSE downloads past year: 3,759 (1,402)
SCIRun/BioPSE downloads total: 34,947

Seg3D downloads: 29,329 (Dec 2006)
ImageVis3D Mobile downloads: 9880 (16,780 - Sept 2009)
ImageVis3D downloads: 4,159 (14,486 - Dec 2008)
ShapeWorks: 2,171 (Aug 2009)
map3d downloads: 6,046
Teem downloads: 17,973

CIBC Dataset Downloads: 8,284
Biomedical Research Impact

Introduction
Clinical Impact

Deep Brain Stimulation
DBP: Chris Butson

C. Butson, G. Tamm, S. Jain, T. Fogal and J. Krüger
Don Tucker

Department of Psychology
Simulate Stresses in the Articular Cartilage of Normal and Dysplastic Hips During Activities of Daily Living

Hip Biomechanics Pipeline:
• CT Scan
• Segmentation
• Mesh Generation
• FE Simulation
• Visualization and Evaluation

Normal Hip Pressures due to Walking
Driving Biological Partners - Current

Nassir Marrouche MD, Chris McGann MD, University of Utah, Image-based Management of Atrial Fibrillation

Jeffrey Weiss PhD, Andrew Anderson PhD, University of Utah, Statistical and Biomechanical Analysis of Hip Dysplasia

John Triedman MD, Matt Jolley MD, Natalia Trayanova, and Tom Pilcher, MD, Children’s Hospital Boston, Stanford University, John’s Hopkins University and University of Utah, Simulation of Cardiac Defibrillation

Christopher R. Butson, PhD, Medical College of Wisconsin, Simulation of Deep Brain Stimulation

Simon Warfield PhD, Children’s Hospital Boston, Bayesian Source Imaging of Pediatric Epilepsy

Don Tucker PhD, Electrical Geodesics Inc. and University of Oregon, High-Resolution Source Imaging From EEG
Driving Biological Partners - Updates

Completed:

Roy Bloebaum MD, Brad Isaacson MD, University of Utah, Simulation of Electric Stimulation for Bone Growth
Charles Keller, MD, University of Texas Health Science Center at San Antonio, Image-Based Small-Animal Phenotyping

Potential New DBPs:

Angela DePace, Assistant Professor2. Institution: Harvard Medical School
Philip A. Zegerman, PhD, Wellcome Trust/Cancer Research UK Gurdon Institute, University of Cambridge, UK
Training Impact: Since 2005

Postdoctoral Fellows:
- Jeroen Sinstra—Research Staff Scientist, Numira Biosciences, Inc.
- Xavier Tricoche—Assistant Professor, Computer Science, Purdue University
- Jens Krueger—Professor, Interactive Visualization and Data Analysis, Saarbrucken

Graduate Students—Ph.D.:
- Seok Lew—Massachusetts General Hospital, Dept. of Radiology
- Sarah Geneser—Post Doctoral Fellow, Stanford University
- Alireza Ghodrati—Draeger Medical
- Saeed Babaeizadeh—Phillips Medical
- Miriah Meyer—Post Doctoral Fellow, Harvard University, Assistant Professor of Computer Science and SCI Institute
- Jason Shepherd—Sandia National Laboratory
- Chris Butson—Assist. Professor, University of Wisconsin
- Sila Kurugol —Postdoc at BWH
- Josh Cates—Research Staff CARMA
Training Impact (Cont.)

Graduate Students—M.S.:
• Anastasia Mironova—Conoco Phillips
• Lee Roy Myers—Instructor, Eastern Wyoming College
• P.J. Hawkes—Medical School, University of Utah
• J.R. Blackham—Apple Computer
• Andrew Keely—Nuance Communications
• Jaume Coll Font – Ph.D. student at the Technical University of Barcelona in Spain

Undergraduate Students:
• McKay Davis—Makai Ocean Engineering, Waimanalo, Hawaii
• Zachary Warnock—Medical School, University of Utah
• Lindsey Healy—Graduate Student, Bioengineering, Univ. of Utah
• Patrick Rasch
• Anatoliy Zharkikh
• Cory Shirts
Outreach SCIx 2011 – November 3-4

SCIx is an open house at the University of Utah's Scientific Computing and Imaging (SCI) Institute. SCIx is a celebration of interdisciplinary research in scientific computing, image analysis and visualization and its contributions in fields as diverse as medical imaging and oil and gas exploration.

www.sci.utah.edu/scix
SClx Video
In the News

Adobe's John Warnock to Keynote SC1x Nov. 4

On Friday, Nov. 4, the University of Utah’s Scientific Computing and Imaging (SCIx) Institute is hosting SC1x, a one-day open house to showcase the innovative research taking place at the institute. John Warnock, co-founder of Adobe and a pioneer in computer graphics, will give a keynote address at the event.

The open house takes place from 11:00 am to 6:30 pm at the Warnock Engineering Building, 72 S. Central Campus Drive in Salt Lake City. The keynote address takes place at 4:00 pm in the building’s auditorium.

SCIx is free and open to the public. SCIx is a collaboration of multidisciplinary breakthroughs in scientific computing, image science visualization, and their impact on fields as diverse as medical imaging and oil and gas exploration. Attendees can visit labs, talk to researchers, and view brief demonstrations.

For more information, visit theSCIx website.
New SCI Institute Web Sites
Summary of Center Impact Assessment

- Technology development/algorithms
  • Papers published
  • Citations to papers

- Software/dissemination
  • New software products
  • Software releases
  • Downloads and citations/acknowledgements

- Scientific Impact
  • Scientific results from DBPs (enabled by TRD)
  • Training- Graduate students/fellows- Tutorials and workshops

- Mechanisms
  - Weekly CIBC Executive Meetings
  - Weekly Software Design and Evaluation Meetings
  - Annual External Advisory Board Meetings
1. The Center remains vital with new collaborations, new algorithms, new software and promising new technologies.

2. The Center continues to bring in new faculty that complement existing strengths. For example, the addition of a computational geometry expert is exciting and will certainly improve the Center’s meshing and modeling capabilities.

3. The Center’s software strategy is sound. New technology is tested in isolated software packages. As this technology evolves, the software will find a place in existing packages like SCIRun or new “toolkits” that will leverage the Center’s software base and software engineering processes.

4. The grander SCI Institute continues to attract high quality faculty and students. There will be opportunities in the future to leverage the work of other Institute organizations.
“Challenge 5 has a focus on ICT for disease prediction, early diagnosis, prevention, minimally invasive treatment, and overall disease management and support to healthy lifestyles. Another focus is on ICT solutions for prolonging independent living and for extending active working life, as well as ICT solutions enabling accessibility of emerging mainstream ICT solutions, and assistive technologies for people with disabilities. A final focus is on ICT tools for governance and policy modelling.”
The Consortium

Introduction

Universities and research institutes
INRIA, Sofia Antipolis, FR
Universitat Pompeu Fabra, ES
Universitar de Valencia, ES
Universidad de Extremadura, ES
University of Karlsruhe, DE
University of Utah, USA

Industrial partners
- St Jude Medical, UK
- Technomed, UK

Hospitals and clinics
- KCL, London UK
- Centre Hospitalier Universitaire de Bordeaux, FR
CIBC Supplement Proposals


- Volume Processing Library
- Unified Volume Rendering Library
- Support for Multi-Channel Data
- Machine Learning Approaches for Interactive Image Analysis
TRD in Multidimensional Biomedical Data Analysis.
Chris Johnson, Robert MacLeod, Ross Whitaker, Orly Alter, Miriah Meyer, and Dana Brooks

- Computational Analysis – Orly Alter
- Visual Analysis – Miriah Meyer
Center Vision
Image-Based Modeling, Simulation, and Visualization

Introduction

- Image & Data Acquisition
- Image Processing
- Lab/Clinic
- Integrated Software Tools
- Geometry Processing
- Modeling, Simulation & Simulation
- Visualization
Nearly six hundred people celebrated the life of Professor Andrew Pullan at The University of Auckland’s Maclaurin Chapel on Tuesday 13 March.
## EAB 2012 Schedule

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