

NA-MIC National Alliance for Medical Image Computing http://na-mic.org

Training & Validation Update

Sonia Pujol, PhD NA-MIC Training Core P.I.



NA-MIC Training Core Mission



RSNA Course



MICCAI DTI Challenge

- Training effort to transfer NA-MIC technology for subjectspecific image analysis to clinical researchers
- Translational research effort to investigate the comparative performance of different algorithms





TRAINING UPDATE





An open-source environment for software developers



An end-user application for clinical researchers

A software platform that is both

- easy to use for clinical researchers
 - easy to extend for programmers

3DSlicer: worldwide impact (2011-2013)



NA-MIC Tutorials

SLICER WELCOME TUTORINI,

- · The SilcerWelcome tutorial is an introduction to Silcer based on the Welcome module.
- Author: Sonia Pujol, Ph.D.
- Audience: First time users who want a general introduction to the software
- Based on: 3D Slicer version 4.8

BLICERAMINUTE TUTORIA

- The Silcer-Minute tutorial is a brief introduction to the advanced SD visualization capabilities of Silcer 4.8.
- Author: Sonia Pujol, Ph.D.
- Audience: First time users who want to discover Siloer in 4 minutes
- Based on: 3D Slicer version 4.2
- The SlicentMinute dataset contains an MR scan of the brain and 3D reconstructions of the anatomy

SLICERY DATA LOADING AND 3D VISUALIZATION

- * The Data loading and 3D visualization course guides through the basics of loading and viewing volumes and 3D models in Silcer4 .
- Author: Sonia Pujol, Ph.D.
- Audience: End-users
- Based on: 3D Silcer version 4.1
 The 2D/Hsualization dataset contain an MR scan and a series of 3D models of the brain
- The 2DVIsualization calaser contain an MH scan and a series of 2D models of the

Tutorials for software developers

SLICERA PROGRAMMING TUTORIAL

- The Hoto Python Programming tworial course guides through the integration of a python module in Stoer4
- Author: Sonia Pujol, Ph.D., Steve Pieper, Ph.D.
- Audience: Developers
- Based on: 3D Blicer version 4.1
- The HelioPython dataset contains three Python Nes and an NR scan of the brain

Specific functions

SLICEPH DIFFUSION TENSOR MAGING TUTORIAL

- The Diffusion Tensor Imaging Tutorial course guides through the basics of loading Diffusion Weighted images in Silver, estimating tensors and generating foer tracts.
- Author: Sonia Pujol, Ph.D.
- · Audience: End-users and developers
- Based on: 3D Silber version 4.3
- * The DTI dataset contains an MR Diffusion Weighted imaging scan of the brain

SLICER4 NEUROSURGICAL PLANNING TUTORIAL

- * The Neurosurgical Planning tutorial course guides through the generation of fiber tracts in the vicinity of a tumor.
- Author: Sonia Pugol, Ph.D., Ran Kikima, M.D.
- Audience: End-users and developers
- Based on: 3D Slicer version 4.3
- * The White Matter Exploration datasets contains a Diffusion Weighted Imaging scan of brain tumor patient.





- Modular multi-level training for expert and non-expert community
 - Tutorials and anonymized datasets for end-users and developers
- Cross platform testing for quality control
- National Alliance for Medical Image Computing http://na-mic.org





New Additions



http://na-mic.org

- Modernization of training portfolio:
 - Drag & Drop feature
 - DICOM viewer
 - new Markups module
 - New tutorials
 - -Cardiac MRI Toolkit (Utah)
 - -HelloCLI (MGH)
 - -DTI Prep (IOWA)
 - -SlicerRT (Queen's University)
 - -3D Printing (BHW)

Preparing Data for 3D Printing



3D Printed Models: Temporal Bone and Mandible





Download Tutorial:

http://wiki.na-mic.org/Wiki/index.php/File:Slicer_3D_Printing_Tutorial.mov

Tutorial and Slide courtesy of Nabgha Farhat, Brigham and Women's Hospital

Acknowledgements: P41EB015898, P41EB015902, U54EB005149



3D Printing Tutorial on YouTube and Google+



Tutorial and Slide courtesy

Nabgha Farhat Brigham and Women's Hsp

Training Portfolio: Quality Control

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Part 3: Liver	
Part 4: Lung	
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threeDView = layoutManager.hreeDWidget(0).threeDView()
redWidget = layoutManager.sliceWidget('Red')
redController = redWidget.sliceController()
viewNode = threeDView.mmTViewNode()
cameras = slicer.util.getNodes('vtkMMMLCameraNode*')
for cameraNode in cameras.values():
 if cameraNode.GetActiveTag() == viewNode.GetID():
 break
mainWindow.moduleSelector().selectModule('Models')
self.takeScreenshot('Liver-Models', 'Models module',-1)
segmentII = slicer.util.getNode('LiverSegment_II')
segmentII.GetDisplayNode().SetVisibility(0)
self.clickAndDrag(threeDView,start=(10,200,end=(10,10))
self.takeScreenshot('LiverSegmentII invisible',-1)

RSNAVisTutorial.py 79% (597,0) Git-3547-match-markups-scale-to-volume-spacin

Self-test infrastructure in Slicer can be used to run nightly tests of the functionality used in tutorials.

A python script is created with commands that automate the steps of the tutorial.

The tests are integrated into Slicer and can be run by users.

The tests are run each night and can be monitored for failure as the code changes.

(slide courtesy of Nicole Aucoin)





RSNA 2013

Hands-on workshops tailored for clinicians, clinical researchers, and scientists at national events, invited seminars, and international conferences



2013: 33 outreach events

22 workshops at national & international venues

Jan-June 2013:

598 participants

- 1. DTI Hands-on course, SPIE 2013, Orlando, Florida (Feb.5)
- 2. 3D Slicer demos, IMAGINE session, European Congress of Radiology, ECR 2013, Vienna, Austria (March 7-11)
- 3. Automatic Segmentation Algorithm workshop (March 8)
- 4. SlicerRT workshop, Medical University Vienna (March 11)
- 5. Imaging in Neuroscience hands-on course, Harvard Catalyst (April 8)
- 6. 3D Slicer hands-on workshop, Tokyo, Japan (April 9)
- 7. 3D Slicer hands-on workshop, Iwate, Japan (April 10)
- 8. AAPM Slicer User meeting Summer meeting, Indianapolis, NH (May 31)
- 9. 3D Slicer Hands-on workshop, BWH, Boston, (June 14)
- 10. DTI In traumatic Brain Injuries, CARS 2013, Heidelberg, Germany (June 26)
- 11. Image-Guided Therapy Workshop, CARS 2013, Heidelberg, Germany (June 30)

2013: 33 outreach events

22 workshops at national & international venues June-Sept 2013 598 participants

11. BRAINSCamp hands-on workshop, Iowa City (August 1st)

- 12. 3D Slicer user group AAPM 2013 meeting, Indianapolis, (August 5)
- 13. MICCAI 2013 DTI Tractography Challenge, Nagoya, Japan (Sept.22)
- 14. MICCAI 2013 CTK Programming Tutorial, Nagoya, Japan (Sept.26)
- 15. 3D Slicer Neurosurgery workshop, PLA General Hospital, Beijing, China (Sept.29)
- 16. 3D Slicer Seminar, Changchun, China (Sept.30)
- 17. 3D visualization of the anatomy using Slicer, Harvard Medical School Gross Anatomy course, (Oct.15)
- 18. 3D Slicer Workshop, Brno, Czec Republic (Oct 17)
- 19. 3D Cranio-Maxillo Facial workshop, CWRU Cleveland (Nov 20)
- 20. 3D Visualization of DICOM images for Radiology Applications, Hands-on course, RSNA 2013, Chicago (Dec.1)
- 21. Quantitative Medical Imaging for Research and Practice, Hands-on course, RSNA 2013, Chicago, (Dec.3)

2013: 33 outreach events

11 presentations and invited lectures

- 1. 3D Slicer lecture, European Congress of Radiology, ECR 2013, Vienna, Austria (March 7)
- 2. 3D Slicer invited lecture, Medical University of Vienna, Austria, (March 11)
- 3. DTI Challenge Poster Presentation, Sonia Pujol, P41 Directors Meeting, Washington DC (March 18-19)
- 4. The MICCAI DTI Challenge, invited lecture, Tokyo Women's University, Tokyo, Japan (April 8)
- 5. The MICCAI DTI Challenge, invited lecture, Jutendo University, Tokyo, Japan (April 8)
- 6. 3D Slicer invited lecture, AAPM New England Chapter Summer meeting, Portsmouth, NH (May 31)
- 7. 3D Slicer Summer Contest (June 28)
- 8. Invited lecture, Brain Mapping for Neurosurgery, 15th World Congress of Neurosurgery, Seoul, Korea (Sept. 11)
- 9. Invited lecture, Insular Gliomas, 15th World Congress of Neurosurgery, Seoul, Korea (Sept.12)
- 10. NA-MIC/NAC Invited Seminar, The 1st Hospital of Jilin University, Changchun, China (Sept.30)
- 11. 3D Slicer Booth, Quantitative Imaging Reading Room, RSNA 2013, Chicago (Dec.1-6)



- Radiotherapy: AAPM 2013
- Radiology: RSNA 2013
- Neuroscience: SPIE 2013
- Cephalometry: CMF Cleveland 2013
- Image-Guided therapy: CARS 2013

NA-MIC workshops reach diverse audiences



Medical Physicists

Neurosurgeons



Cranio Maxillo Facial Workshop

- Theme: Open-source 3D image analysis in dentistry
- Workshop Faculty Beatriz Paniagua, UNC Tung Nguyen, UNC Lucia Cevidanes, U.Michigan Vinicius Boen, U.Michigan







Autoseg workshop, Boston



- One-day workshop on the design of algorithms for automatic segmentation of medical images.
- Greg Sharp MGH, Boston

BRAINS Camp 2013, Iowa City



- Two-day BRAINSCamp workshop at the Iowa Institute for Biomedical Imaging
- Workshop Faculty:
- Hans Johnson, Vince Calhoun, Vince Magnotta



AAPM 2013, Indianapolis



- Theme: 3DSlicer for radiation therapy research
- Gregory Sharp, Nadya Shusharina, James Shackleford, MGH

Joint meeting of the American Association of Physicists in Medicine (AAPM) and the Canadian Organization of Medical Physicists (COMP)





SPIE Medical Imaging

- 4-hour course on the fundamentals of the acquisition, analysis and validation of Diffusion Tensor Imaging (DTI) data (Pujol, Styner, Gerig)
- End-to-end medical image processing solution using Slicer4



NA-MIC Outreach events at International conferences



TBI Workshop, CARS 2013, Germany

Modeling brain injury and trajectory of brain changes from longitudinal multimodal imaging

M. Vannier: Diffusion MRI in Traumatic Brain Injury



RADIOLOGY AND SURGERY

- Guido Gerig
- U of Utah, SCI Institute and School of Computing &
- UCLA LONI (Jack Van Horn, Andrei Irimia, Arthur Toga, Vespa) &
- NA-MIC Research Team (Kikinis et al.)







CARS 2013 IGT Workshop, Germany

CARS 2013 IGT workshop

- 8:30-8:35 Opening remarks and Introduction
- 8:35-8:45 Presentation of the NA-MIC (Sonia Pujol)
- 8:45-9:15 Open-source software for Medical Image Computing and Computer Assisted Interventions (Steve Pieper): An introduction to CTK
- 9:15-9:45 Rapid prototyping of US-guided needle placement applications (Gabor Fichtinger)
- 9:45-10:15 Device integration for Image-Guided Therapy (Noby Hata)
- 10:15-10:30 Coffee-Break
- 10:30-11:45 Hands-on 3D Slicer session: Neurosurgical Planning Tutorial (Sonia Pujol)
- 11:45-12:00 The DTI Tractography Challenge for Neurosurgery (Sonia Pujol)
- 12:00-13:00 Lunch break
- 13:00-13:30 Introduction to the Medical Imaging Interaction Toolkit (Marco Nolden)
- 13:30-14:00 Demonstration of the MITK Workbench (Andreas Fetzer)
- 14:00-14:20 Interoperability and extension mechanisms in CTK (Sas
- 14:20-15:00 Image-guided therapy within MITK: Tracking-based app imaging support and ultrasound navigation (Alexander Seitel)
- 15:00-15:30 Coffee break
- 15:30-16:15 Demonstration of IGT applications (Alexander Seitel and
- 16:15-17:00 Extending the MITK Workbench: CTK Plugin generator (Sascha Zelzer)

Joint MITK-Slicer event

NA-MIC Workshop Faculty:

- Sonia Pujol
- **Steve Pieper**
- **Gabor Fichtinger**



June 26-29, 2013 Heidelberg, Germany

CARS 2013

27th International Congress and Exhibition



European Congress of Radiology (ECR 2013, Vienna



- Oral sessions & IMAGINE session Demos
 - « The 3DSlicer open-source platform for segmentation, registration, quantitative imaging and 3D visualization of biomedical image data. » Sonia Pujol, Ph.D
- « SlicerRT 3D Slicer based open-source toolkit for radiation therapy research ». Csaba Pinter, M.Sc.

RSNA 2013, Chicago





- RSNA 2013: 75,000
 participants
- Joint NA-MIC/NAC/ NCIGT week- long series of events
 - 2 Refresher courses:
- 3 hours hands-on courses (>100 attendees)
 - Quantitative Imaging Reading Room:
- 54 hours Slicer demos

nttp://na-mic.org

1-week long series of events at RSNA 2013

Sunday, December 1	Monday, December 2	Tuesday, December 3	Wednesday, December 4	Thursday, December 5	Friday, December 6
8:00am-11:00am: 3D Slicer Exhibit: Quantitative Imaging Reading Room. # Lakeside Learning Center Hall E, Exhibit LL- QRR3007.	 m-11:00am: 3D licer Exhibit: titative Imaging ading Room. # eside Learning Center IE, Exhibit LL- QRR3007. 0am-12:30pm: Refresher Course: tittative Medical ping for Clinical rch and Practice: -on Workshop." # Pujol, Katarzyna ira, Ron Kikinis oom S401CD. m-1:30pm: Meet- xperts Session *, Slicer Exhibit: titative Imaging center I:15pm-1:15pm: Meet- The-Experts Session *, 3D Slicer Exhibit: Quantitative Imaging Reading Room. # Lakeside Learning Center Hall E, Exhibit LL- QRR3007. 1:15pm-6:00pm: 3D Slicer Exhibit: titative Imaging center I:15pm-6:00pm: 3D Slicer Exhibit: Quantitative Imaging Center I:15pm-6:00pm: 3D Slicer Exhibit: Quantitative Imaging Center I:15pm-6:00pm: 3D Slicer Exhibit: Quantitative Imaging Center Hall E, Exhibit LL- QRR3007. I:15pm-6:00pm: 3D Slicer Exhibit: Quantitative Imaging Center Hall E, Exhibit LL- QRR3007. 	8:00am-11:00am: 3D Slicer Exhibit: Quantitative Imaging Reading Room.« Lakeside Learning Center Hall E, Exhibit LL- QRR3007.	3:00am-11:00am: 3D Slicer Exhibit: Quantitative Imaging Reading Room. # Lakeside Learning Center Hall E, Exhibit LL- QRR3007. Silcer Exhibit: QRR3007. Reading Room. # Lakeside Learning Center Bilcer Exhibit: Quantitative Imaging Reading Room. # Lakeside Learning Center Lakeside Learning Center Lakeside Learning Center Hall E, Exhibit LL- QRR3007. QRR3007.		
11:00am-12:30pm: RSNA Refresher Course: "Quantitative Medical Imaging for Clinical Research and Practice:		ding Room. # side Learning Center E, Exhibit LL- RR3007. 1-1:15pm: Meetperts Session #, Bilder Exhibit: tative Imaging ding Room. # side Learning Center E, Exhibit LL- of DICOM Images for Radiology Applications: Hands-on Workshop." # Sonia Pujol, Kitt Shaffer, Ron Kikinis Room S401CD. 12:15pm-1:15pm: Meet- The-Experts Session #, S 3D Slicer Exhibit: Quantitative Imaging Reading Room. # Lakeside Learning Center E, Exhibit LL- RR3007. n-6:00pm: 3D Cer Exhibit: tative Imaging ding Room. # Lakeside Learning Center Hall E, Exhibit LL- QRR3007 1:15pm-		Reading Room. Lakeside Learning Center Hall E, Exhibit LL- QRR3007.	8:00am-12:45pm: 3D Slicer Exhibit: Quantitative Imaging Reading Room.# Lakeside Learning Center Hall E, Exhibit LL- QRR3007.
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1:30pm-6:00pm: 3D Slicer Exhibit: Quantitative Imaging Reading Room.# Lakeside Learning Center Hall E, Exhibit LL- QRR3007.		6:00pm: 3D Slicer Exhibit: Quantitative Imaging Reading Room. # Lakeside Learning Center Hall E, Exhibit LL- QRR3007.	Lakeside Learning Center, Hall E, Exhibit LL-QRR3007.		

Quantitative Imaging Reading Room Exhibit

RSNA2013 Quantitative Imaging Reading Room

The 3DSlicer Open Source Software Platform for Segmentation, Registration, Quantitative Imaging, and 3D Visualization of Multi-Modal Image Data

Sonia Pujol, Ph.D., Steve Pieper, Ph.D., Andriy Fedorov, Ph.D., Ron Kikinis, M.D.

imaging data for guantification and analysis.

About 3D Slicer

Segmentation & Registration Segmentation is required for defining features of interest in

3D Slicer is a multi-platform, free, open source and extensible software package for visualization and medical image computing. The software platform is community created for the purpose of subject specific medical image analysis and visualization.

30 Slicer

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MRN -

The Mary Televano' Relayer allows the alongsate

«Multi-modality imaging including, MRI, CT, US, nuclear medicine, and microscopy Multi organ from head to toe

 Bidirectional interface for devices Expandable and interfaced to multiple toolkits

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Disatlatimer: 3D Silser is not FDA approved or CS marked, and is for research

Quantitative Analysis

Many hundreds of imaging biomarkers are used in clinical practice, drug discovery and development. A free and open source platform can improve access to standard methods of image quantification and rapidly translate experimental methods into the clinical research setting for validation and refinement.



Clinical Research Applications

3D Slicer has been used in clinical research, with IRB clinical protocols appropriately created and managed. In imageguided therapy (IGT) research, Slicer is frequently used to construct and visualize collections of MRI data that are available pre- and intra-operatively, and to display the tracked spatial position of surgical instruments.



Table Contract Contract Statement Statement Statement Statement



Multi-modality Visualization A combined visualization of multiple imaging modalities and

derived data can provide clinician scientists with an

integrated understanding of anatomy and pathology.



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3D Slicer offers a suite of layouts and the ability to visualize many types of data including: greyecale volumetric data perameter maps and VOIs
 surface models & picets
 measurement tools & annotations
 tracking devices Fast new hardware accelerated volume rendering

is available in 3D Silcer version 4.2.





Community, Learning & Support



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3D Slicer has a variety of interactive and

Scogle "na-mic registration documentation" for t collection of Silcer registration cases and recipes for the extensive





RSNA 3DVisualization Course

3D interactive visualization of liver & lung segments 6th edition (RSNA 2008, 2009, 2010, 2011, 2012, 2013)

Course Instructors:

- Dr. Kitt Shaffer, MD, PhD,
 Vice Chairman for Radiology
 Research, BU Medical Center
- Sonia Pujol, Ph.D., BWH





Measurements of small volumetric changes in slow growing tumors, and quantitative imaging analysis of FDG-PET/CT data 5th edition (RSNA 2009, 2010, 2011, 2012, 2013)

Course Instructors:

- Katarzyna Macura, MD, PhD, JHU
- Sonia Pujol, Ph.D., BWH



RSNA Quantitative Imaging Course: Breast Imaging



RSNA Quantitative Imaging Course

The "Quantitative Medical Imaging for Clinical Research and Practice" course (Pujol, Macura, Kikinis) has been selected by Radiology Today in *"Challenges and Opportunities - A Sneak Peek at RSNA 2013 With Views From President Sarah S. Donaldson, MD" Radiology Today Vol. 14 No. 10 P. 24 »*

SNEAK PEER: Society President States Rev Challeng

Categories: Finance and Support Research in Radiologic Science' and 'Promote and Advance Precision Radiology without Increasing Costs''







National Alliance for Medical Image Computition http://na-mic.org

Slicer Course on RSNA 2013 postcard



World Congress of Neurosurgery 2013





Fowards Validation of DiffusionTensor Imaging Fractography for Neurosurgical Planning: The MICCAI DTI Fractography Challenge,



Sonia Pujol, Alexandra Golby, Guido Gerig, Carl-Fredrik Westin, Martin Styner, William Wells, Sylvain Gouttard, Carlo Pierpaoli, Arya Nabavi, Ron Kikinis

Brain Mapping and Intraoperative Imaging II, Sept.11, WFNS 2013, Oral presentation



World Congress of Neurosurgery 2013



Invited lectures:

Non-invasive Brain Mapping using Diffusion MRI Tractography, Sonia Pujol Role of Brain Mapping for Neurosurgery, Sept.11 WFNS 2013, Invited lecture

Preoperative Planning of Insular Gliomas Resection Using Multimodal MRI, Sonia Pujol

Insular Gliomas: From Anatomy to Management, WFNS 2013, Invited lecture

http://na-mic.org

liance for Medical Image Computing

Congress of Neurosurger

Korea - 2013

NA-MIC Training Core International Collaborations


NA-MIC Invited Workshop in Iwate



National Allance for Medical Image Computing http://na-mic.org Invited 2-day event: Image-Guided Therapy Research using Open Source Free Software 3D Slicer

Workshops Faculty

- Sonia Pujol, BWH
- Ron Kikinis, BWH
- Noby Hata, BWH
- Rie Oyama, Iwate University

NA-MIC Collaboration with Iwate University, Japan

Ultrasound Obstet Gynecol 2013; 42: 609-610 Published online 2 October 2013 in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/uog.12484

Picture of the Month

Towards improved ultrasound-based analysis and 3D visualization of the fetal brain using the 3D Slicer

R. OYAMA*, M. JAKAB†, A. KIKUCHI*, T. SUGIYAMA*, R. KIKINIS† and S. PUJOL†

*Iwate Medical University, Department of Obstetrics and Gynecology, Morioa, Japan; †Harvard Medical School, Brigham and Women's Hospital, Department of Radiology, Boston, MA, USA

Magnetic resonance imaging (MRI) provides useful three-dimensional (3D) information; however, there are some restrictions on its use during pregnancy due to safety concerns. In addition, fetal movements can create artifacts on MR images, as image quality depends on position of the fetus and placenta. In the past decade, 3D ultrasound imaging has been used in clinical practice to investigate the formation and volumetric size of critical anatomical structures of the fetus. However, current techniques rely mainly on analysis of sections of interest that do not integrate anatomical information concerning the shape of these structures.





Figure 2 Result of 'Grow Cut Segmentation' of the fetal brain using the 3D Slicer. The blue structure represents the choroid plexus, and



- 2010: Slicer RSNA Course
- 2012-2013: One-Year research visit at SPL
- 2013: Ultrasound Obst. Gyn. Paper
- 2013: Iwate Workshop



NA-MIC Invited Workshop in Tokyo

Tokyo 2013 Training

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English Page

Objective:

The purpose of this workshop is to introduce Slicer 4 in Japanese image processing community and invited them to participate in Open Source software effort within medical image processing community. The learning objective of the workshop is to 1) understand the basic usage of 3D Slicer version 4, (2) perform image segmentation in Slicer 4, (3) learn how to use Slicer in image-guided therapies. The targetted audience is scientists and graduate students in medical image processing and image guided surgery.

Dates and Location:

- Date: Tuesday 4/9/2013
- Location: AZE, Tokyo Office

日本語ページ

目的

このコースは、オープンソースソフトウェア3D Slicer Gのバージョン4について国内で始めて行うチュート リアルです。新しいSlicerを活用して画像誘導手術シミュレーション、ナビゲーション、医用画像処理につ いて体験講義を行うことを目的としています。通常の講義とは異なり、実際に自分のパソコンにソフト ウェアをダウンロードして、臨床で用いられている画像データを使いながら、直接「手」で先端研究を感 じてもらうことがコースの目的です。コースで使用するソフトウェアは無償でプログラムソースコードが 公開されており、コース終了後はこのソフトウェアを中心に研究を展開することができます。この展開方 法についてもコース内で触れます。ハンズオンセミナーの質をあげるため、受講者の人数を制限し受講者 に対する講師陣の人数を限りなく多くするようにとりはからっています。 Invited Workshop:

Faculty:

- Sonia Pujol, BWH
- Ron Kikinis, BWH
- Noby Hata, BWH
- AZE R&D Boston Karl Diedrich, PhD
- AZE R&D Boston Audience: 31 engineers



Neurosurgeons: PLA General Hospital



One-day hand-on slicer training workshop on neurosurgical planning **Faculty:** Sonia Pujol, Ph.D. Ron Kikinis, MD Steve Pieper, PhD

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Invited NA-MIC seminar First Hospital of Jilin University, Changchun, China



NA-MIC Faculty: Ron Kikinis, MD Sonia Pujol, Ph.D. Steve Pieper, PhD

Dissemination Update

16th Project Week: Salt Lake City, Utah, January 2013

•80 attendees: 17 academic institutions, 4 companies

•54 Projects: TBI, Atrial Fibrillation, Slicer 4 Extensions, Huntington's Disease, Head and Neck Cancer, Stroke, IGT, Radiation Therapy, Medical Robotics, Infrastructure Engineering

17th Project Week: MIT, Summer June 2013

•104 attendees: 22 academic institutions, 13 companies

•75 Projects: Huntington's Disease, TBI, Atrial Fibrillation and Cardiac Image Analysis, Radiation Therapy, IGT and Device Integration with 3D Slicer, COPD, and Infrastructure Engineering



National Alliance for Medical Image Computing http://www.na-mic.org Tina Kapur, Ph.D., Co-Pl Steve Pieper, Ph.D., Co-Pl





Validation Update Effort: the MICCAI DTI Challenge



DTI for Neurosurgery: Capabilities



- Non-invasive 3D visualization of peritumoral white matter pathways
- Spatial relationship of a tumor with tracts involved in motor, visual or language function
- Spatial relationship between the tracts and eloquent cortex

DTI Tractography for neurosurgery: Current Limitations



- Diffusion properties can be affected by the presence of a lesion or edema
- Crossing fibers areas are challenging (e.g. centrum semi-ovale)
- Brain shift issue as with any pre-op imaging modality



Potential impact of tractography errors on neurosurgical outcomes



False-negative tracts:

→risk of postoperative neurological deficit

False-positive tracts

 \rightarrow risk of incomplete resection

True positive tracts but not essential tracts:

 \rightarrow risk of incomplete resection

DTI Tractography research



The complexity of DTI data has fostered many exploratory activities in new computational approaches for tracing white matter pathways.



















Corticospinal Tract 18 methods



Need for validation of DTI tractography findings

MICCAI 2012 DTI Challenge





MICCA 2012 DTI Tractography Challenge, Oct. 1st, 2012, Nice, France (2nd Edition) MICCA 2011 DTI Tractography Challenge, Sept. 18, 2011, Toronto, Canada (First Edition)

Previous Editions

Goal:

 To define standards to evaluate tractography methods for subjectspecific analysis and ascertain quality features for surgical guidance.



 Exploratory work on validation of DTI tractography

 Cross-comparison of tractography algorithms on major white matter fascicles



DTI Challenge Working Group



Working group that brings together medical and technical people:

- 11 practicing neurosurgeons
- 19 tractography teams (USA, Canada, France, Germany, Japan, China, Spain, Italy, Mexico, Turkey)
- Annual DTI Challenge
 workshop at MICCAI
 conference

DTL Challenge'11, Toronto

DTI Challenge Working Group (MICCAI 2011, 2012 & 2013)

9 Research Scientists

Sonia Pujol, BWH (P.I) Ron Kikinis, BWH Guido Gerig, SCI Utah Laurent Chauvin, BWH Isaiah Norton, BWH Martin Styner, UNC CF Westin, BWH William Wells, BWH Carlo Pierpaoli, NIH

11 Neurosurgeons

Dr. Alexandra Golby, Boston, USA

- Dr. Arya Nabavi, Kiel, Germany Dr. Sandrine De Ribaupierre, London, Ontario, Canada
- Dr. David Fortin, Sherbrooke, Canada
- Dr. Francesco Cardinale, Milan, Italy
- Dr. Xiaolei Chen, Beijing, China
- Dr. Ye Li, Beijing, China
- Dr. Hugues Duffau, Montpellier Hospital France
- Dr. Yoshihiro Muragaki, Tokyo, Japan Dr. Luke Maczyn, Philadelphia, USA Dr. Yasukazu Kajita, Nagoya, Japan

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- 3. H.Jonhson, University of Iowa, USA
- 4. O.Commonwick, A. Stamm, INRIA Rennes, France
- 5. B.Vemuri, University of Florida, USA
- 6. G. Veni, SCI Institute, SLC, USA
- 7. A. Tristan-Vega, BWH-LMI, Boston, USA
- 8. P. Neher, German Cancer Research Centre, Germany
- 9. Y.Shi, UNC Chapell Hill, USA
- 10. X. Chen, PLA General Hospital, China
- 11. M. Tamura. Tokyo Women's Med. University, Japan
- 12. N. Gajawelli, Children's Hospital, Los Angeles, USA
- 13. Y. Masutani, The University of Tokyo Hospital, Japan
- 14. F. Cardinale, Hospitale Niguarda, Italy
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- 16. S. Pathak, University of Pittsburgh, USA
- 17. M. Descoteaux. Sherbrooke University, Canada
- 18. R.Verma, Upenn, USA
- 19. J. Klein, Fraunhofer MEVIS, Germany

DTI Challenge Working Group (2011-2013)





MICCAI 2012 DTI Tractography Challenge a 2nd addition of the MICCAI DTI To Im MICEAU 2012

A Grand Challenge pronto, Canada

October 2012 - Acros 🖻 1. 🕤 📷



MICCAI 2011 Workshop September 18, 9am-6or estin Harbour Castle

DTI Challenge 1st Edition MICCAI 2011 Toronto, Canada

DTI Challenge 2nd Edition **MICCAI 2012** Nice, France

DTI Challenge 3rd Edition

MICCAI 2013 Nagoya, Japan

DTI Challenge 3rd Edition (MICCAI 2013, Nagoya, Japan, Sept. 22, 2013)



10 teams – 10 neurosurgeons

DTI Challenge 3rd Edition (MICCAI 2013, Nagoya, Japan, Sept. 22, 2013)



10 teams – 10 neurosurgeons



DTI Challenge Datasets



- Collaboration with NAC DBP4/NCIGT (LGG & HGG cases)
- T1,T2, pre-op and intra-op DWI anonymized scans from brain tumor patients operated on in the AMIGO suite
- Registration, manual segmentation and 3D modeling of tumor regions

Standardization effort using 3D Slicer



3D Slicer as a platform for technology comparison

MICCAI 2013 DTI Challenge



Evaluation of Tractography Results



- Standardized review by a panel of neurosurgeons and DTI experts
- Quantitative assessment of variability among methods



Standardized review questionaire



(1=Poor, 2=Fair, 3=Good, 4=Very Good, 5=Excellent)

Team1	0	0	0	0	0
Team2	\odot	0	0	0	\odot
Team3	0	0	0	0	0
Team4	Θ	0	0	0	Θ
Team5	0	0	0	0	0
Team6	Θ	Θ	Θ	Θ	\odot
Team7	0	0	0	0	0
Team8	0	0	Θ	0	\odot
Team9	0	0	0	0	0
Team10	\odot	0	\odot	\odot	\odot

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C1. Anatomical Correctness





C2. False-positive tracts



C3. False-negative tracts





C4. Peritumoral Tracts









Quantitative Evaluation



- Metric 1: Degree of bundle overlap
- Metric 2: Distance between tracts
- Metric 3: Bundle Profile of Fractional Anisotropy







MICCAI 2013 Results





Q1: Do the different tracts overlap ?

Dice Coefficient of Bundle Overlap
Dice coefficient of bundle overlap

Tumor Side	Patient 1 (Tumor Side)	Patient 2 (Tumor Side)	Patient3-20dir (Tumor Side)	Patient 3- 30dir (Tumor Side)		
Мах	0.427	0.403	0.365	0.465		
Min	0.083	0.027	0.011	0.035		
Mean	0.245	0.190 <mark>S</mark>	imilar (weak) overlap values			
STD	0.08	0.095 <mark>ti</mark>	imor vs. healthy side			
Healthy Side	Patient 1 (Healthy side)	Patient 2 (Healthy side)	Patient 3-20 dir (Healthy side)	Patient 3-30dir (Healthy side)		
Healthy Side Max	Patient 1 (Healthy side) 0.393	Patient 2 (Healthy side) 0.411	Patient 3-20 dir (Healthy side)	Patient 3-30dir (Healthy side) 0.47		
Healthy Side Max Min	Patient 1 (Healthy side) 0.393 0.064	Patient 2 (Healthy side) 0.411 0.048	Patient 3-20 dir (Healthy side) 0.570 0.0284	Patient 3-30dir (Healthy side) 0.47 0.04		
Healthy Side Max Min Mean	Patient 1 (Healthy side) 0.393 0.064 0.24	Patient 2 (Healthy side) 0.411 0.048 0.216	Patient 3-20 dir dir 0.570 0.0284 0.212	Patient 3-30dir (Healthy side) 0.47 0.04 0.217		



Q2: Does the variability among methods depend on the anatomical location ?

FA Profile along the CST





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Q3: Are the different methods in agreement in the lateral projections of the CST ?









































DTI Challenge Workshop findings

Table 1: Dice Coefficient for volumetric overlap between tracts (DTI Challenge'12)

Team	Patient1		Patient2		Patient3		Patient4	
	Left	Right	Left	Right	Left	Right	Left	Right
'eam1	27.32	20.7	24.58	22.6	N/A	N/A	N/A	N/A
'eam2	19.00	19.76	20.09	17.81	20.38	25.13	22.01	22.89
'eam3	21.07	17.84	24.63	19.81	20.44	23.7	26.19	27.2
'eam4	28.58	23.93	23.74	17.04	21.6	25.77	19.99	23.53
'eam5	27.64	25.19	30.3	26.78	25.43	29.68	26.51	26.89
'eam6	25.87	28.16	29.94	25.34	13.79	16.79	11.48	7.68

Team



- Large variability among tractography methods
- Improved results for some of teams from year 1 to year 3
- Learning experience and Service to the community
- Neurosurgery in itself represents a unique opportunity for validation of DTI tractography

On-going work by DTI Challenge Group



- Two-way exchange between the scientists who create the tools and the neurosurgeons who will use the tools in the clinics.
- Multidisciplinary effort (Neuranatomy, Neurosurgery, Radiology, Mathematics, Computer Science, Statistics) that requires collaborative work
- Fourth Edition DTI Challenge Workshop, MICCAI 2014

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NA-MIC Training Core 2005-2014



NA-MIC Training Core



Randy Gollub,
M.D., Ph.D.,
MGH



National Venues

- Harvard,
- MIT,
- UCSF,
- UCLA,
- UCSD,
- Stanford,
- Dartmouth,
- NIH,
- University of New Mexico,
- University of lowa,
- St Louis University,
- Duke University,
- UNC,
- NCI,
- NLM,
- MIND,



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- Montreal, Canada
- Munich, Germany
- London, UK
- Dundee, UK
- London, Canada
 - Sydney, Australia
- Melbourne, Australia
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Tutorials and Slides in a 10 year span

3D models of the liver





Tutorials and Slides in a 10 year span



Darmouth Medical Center May 26-27, 2005









NA-MIC Training 2005-2014:



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Participants: : 235 : 370 : 250 : 270 : 635 : 457 : 704 : 585





S. S. COG - SPECEMENT

3,506 NA-MIC Trainees in 116 Outreach events in 14 different countries





2014 Update











2005-2014: 3,506 clinical researchers and scientists trained through NA-MIC Training Core Effort





