The 3DSlicer open-source platform for segmentation, registration, quantitative imaging and 3D visualization of biomedical image data

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3DSlicer

- Slicer is a freely available open-source application for viewing, analyzing and interacting with biomedical imaging data.
3DSlicer

- Slicer is a **freely available open-source** application for viewing, analyzing and interacting with biomedical imaging data.

- Slicer is a **multi-platform** software on Windows, Linux, and Mac.

Get Slicer 4.

Slicer 4 is the latest stable version of 3D Slicer, a free, comprehensive software platform for medical image analysis and visualization developed with NIH support.

3D Slicer is distributed under a permissive BSD-style open source license. It has a thriving user and developer community.

<table>
<thead>
<tr>
<th>Pre-compiled binaries</th>
<th>Windows</th>
<th>Mac OS X</th>
<th>Linux</th>
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| nightly build |                   |
|---------------|                   |
| 64 bit        | nightly 64 bit installer 2012-04-09 |
| 32 bit        | nightly 32 bit installer 2012-04-09 |

**System requirements**

Slicer requires 1GB of RAM absolute minimum, with more highly recommended. Common data sets may require 4GB or more RAM for processing. A fast graphics card or GPU that supports OpenGL is also recommended.

Slicer is built and tested on many hardware and software platforms. 3D Slicer runs on Microsoft Windows XP, Vista, and Windows 7; Mac OS X versions 10.5 Leopard, 10.6 Snow Leopard, and 10.7 Lion; and a variety of Linux distributions.
3DSlicer

- Slicer is a **freely available open-source** application for viewing, analyzing and interacting with biomedical imaging data.

- Slicer is a **multi-platform** software on Windows, Linux, and Mac.

- Slicer is a **multi-institutional effort** mainly supported by the National Institute of Health.
Slicer 17th year Anniversary

- 1997: Slicer started as a Master’s thesis between the Surgical Planning Lab (Harvard) and the Computer Science and Artificial Intelligence Laboratory (CSAIL) at MIT

- 2014: International open-source platform developed through a multi-institution effort

P.I. Prof. Ron Kikinis, BWH, Harvard
Slicer License

• Slicer is distributed under a BSD-style license agreement with no restriction on use

• Slicer is not FDA-approved nor CE-marked

• 3D Slicer bridges the “valley of death” for subject specific analysis
An interdisciplinary platform

An open-source environment for software developers

An end-user application for clinical investigators and scientists

A software platform that is both easy to use for clinical researchers and easy to extend for programmers
Slicer Is Open

• Open Science = Open Source + Open Data + Open Community
Slicer Open Community

- 80 authorized developers contributing to the source code
- >700 subscribers on user and developer mailing list
- > 55,000 downloads of Slicer4 since November 2011
Slicer 4 download statistics

Total matching downloads: 132619

Date range: forever
Release type: any
Browser type: desktop

Download location
By Country  By Filename  By Month

Map  Satellite
Bridging the gap to accelerate translational research

Algorithm Development

Problem solving

Bridging the communication gap requires a collaborative environment that fosters exchange of specialized knowledge and expertise between clinical researchers and scientists.

Image courtesy of Arya Nabavi, MD
Slicer is 17 year old

• Every 4-5 year: Slicer versions: Major architectural, functional and GUI redesign

• Every 6 month: Within each version, updated release

• Every day!: Binary installation packages to access bleeding-edge functionality
Slicer is built every night

<table>
<thead>
<tr>
<th>Nightly-Packages Site</th>
<th>Build Name</th>
<th>Update Files</th>
<th>Update Error</th>
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<th>Test Fail</th>
<th>Test Pass</th>
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Slicer is under active development: built every night on every platform
Slicer Bug Tracker

Unassigned [ ] (1 / 10 / 29)
- 0001352 Resample/Slicer/DTI module does not accept DRI input
- 0000924 Volume rendering volume received from OpenIGTLink
- 0001350 Scrolling volume slices past the last slice
- 0001019 Texts in 3D are hard to see
- 0001018 Color scale
- 0001016 Effect of matrix bottom view in Transforms module
- 0001010 Problem with fiducial registration
- 0001009 Saving and reopening .nrrd problem
- 0001007 Sceneview rounding problem with LUT and with VR
- 0001008 Ensure Capitalization rule is respected all over Slicer

Resolved [ ] (1 / 10 / 130)
- 0001024 Centralize revision/branch name of Slicer
- 0001022 Fix warning related to Slicer/Fundus/GenerateExtensionDescription
- 0001027 SVN download of loadable extension modules does not work
- 0001027 SVN download of loadable extension modules does not work
- 0001025 windows build/run issues as of sun 193000
- 0001026 Building (CMake, Superbuild) - 2012-02-24 16:06
- 0001025 To avoid a RegisterApplication / CSCsDefaultCorrection error, create a template of launch file for dashboard
- 0001024 No version in mac bundle
- 0001023 update of the mouse mode toolbar
- 0001022 Untogglie "Place a fiducial" on click
- 0001021 make RAS box axis labels visibility camera dependent
- 0001020 ((documentation/(documentation/branch)/module-category)) doesn't support extra newline spacing in XML Documentation - 2012-04-23 13:47

Recently Modified [ ] (1 / 10 / 776)
- 0001055 Link errors during CTK build
- 0001053 Crash on exit and other issues
- 0001052 Found PythonLink: ... get_hnames, component unknown, component optimized
- 0001051 CMake: Superbuild - 2012-04-27 07:40
- 0001050 CMake: Superbuild - 2012-04-27 16:44
- 0001049 drag & drop, option to load view settings
- 0001048 Model to Label Map not working
- 0001047 Extensions download from SVN repository fails
- 0001046 camera position after loading scene
- 0001045 VTK Qt designer plugins are missing
- 0001046 Added Test to make slicer starts

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Interoperability with software package and libraries

• Open-science and open-community philosophy

• File Format compatibility

• Complementary aspects of different open-source software on specialized functionalities
Slicer Extension Manager

Slicer is Extensible through plugins

Slicer Extension Catalog offers the possibility to the user to download additional Slicer modules
Slicer4 core functionalities include 108 modules, and represent 700,000 lines of code.
Core Functionalities

- Visualization
- Segmentation
- Registration
- Reconstruction
- Diffusion
- Image Guided Therapy
- Quantification
- Reporting
DICOM module
DICOM module

- Interface Between DICOM and Slicer
  - Core DICOM Parsing in DCMTK/CTK
  - Data Pre-Cached in Database
  - MRML Manipulation in Slicer Module Logic

- Patient/Study/Series Browser
  - Offers Slicer Interpretation of Selected Data
  - Multiple Interpretations where DICOM Data is Ambiguous
Slicer applications

- Driving Biological Projects leading to the development of new tools
- Applied science oriented toward subject specific analysis in the presence of pathology
- Example: Image-guided therapy
Slicer use in clinical research environment

- AMIGO, BWH, Boston, USA (DTI)
- Slicer RT – Canada
  (ECR 2013 IMAGINE Session, ‘SlicerRT – 3D Slicer based open-source toolkit for radiation therapy research’. Pinter et al)
- Quantitative Image Network collaboration with German Cancer Research Institute (PET/CT)
Improving Patient Care with AMIGO
Advanced Multimodality Image Guided Operating Suite
Image-Guided Therapy

Image-guided therapy for prostate interventions:
• Brachytherapy Planning
• Navigation for Biopsy


Image Courtesy of Steven Haker, PhD and Clare Tempany, MD
Neurosurgical planning

Slicer modules used for
- DWI denoising
- T1/T2/DTI Registration
- Tumor Segmentation
- Tractography with Labelmap Seeding
- Tractography with Fiducial Seeding

Image courtesy R.Kikinis
Fiducial Seeding

Example of on-the-fly exploration of white matter structures in the contralateral side of the tumor
Tractography for neurosurgical planning

Tractography has the potential to bring valuable information to the neurosurgeon

- Spatial relationship between the tract and the tumor
- Demonstration of tract displacement
- Assessment of tumor infiltration
CST Reconstruction: Method #1
CST Reconstruction: Method #2
How to choose?

Neurosurgeons face the challenge of selecting the appropriate tractography method in the absence of ground truth.
DTI Challenge Project

Goal:

- To define standards to evaluate tractography methods for subject-specific analysis and ascertain quality features for surgical guidance.
Challenge Datasets

- T1, T2, DWI, DTI
- Pre-segmented tumor regions
- 3D White Matter Surface
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
DTI Challenge Working Group (2011-2013)

DTI Challenge 3rd Edition
MICCAI 2013
Nagoya, Japan

DTI Challenge 2nd Edition
MICCAI 2012
Nice, France

DTI Challenge 1st Edition
MICCAI 2011
Toronto, Canada
Bridging the gap to accelerate translational research

Algorithm Development

Problem solving

GAP

Image courtesy of Arya Nabavi, MD

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Slicer Training History: 2005-2013

- Training Core Component of two major NIH-funded consortia: the National Alliance for Medical Image Computing (NA-MIC) and the Neuroimage Analysis Center (NAC) (P.I. Ron Kikinis)

- Accelerating the translation of new technology into new skills of scientists and clinical investigators
Slicer Training Workshops

- 1-2 day hands-on events
- Thematic
  - DTI
  - Image-guided therapy
  - 3D Visualization for radiological applications
  - PETCT SUV Computation
- 15-25 all-level participants
Slicer Training Events

Hands-on courses at major international conferences

- **SfN** 2009, 2011
- **SPIE** 2012, 2013
- **CAOS** 2010
- **CARS** 2010, 2012, 2013
- etc…
Slicer Training Events

Invited workshops at international venues:

- PLA General Hospital, Beijing, China,
- Tokyo Women’s Medical University, Japan
- IHK Akademie Westerham, Munich, Germany
- Rey Juan Carlos Universidad, Spain
Project Weeks

- Bi-annual week of hands-on programming
- Practical exchange of idea and experience
- 2010: 126 international attendees, 71 projects, 8 countries (Austria, England, France, Germany, Italy, Japan)
- 19 project weeks in the US since 2005
Conclusion

• Slicer is an open-source research platform for the rapid development of biomedical image analysis tools.

• Slicer community is open community with contributors from all over the world

• Slicer is a versatile platform for translational research and subject specific analysis of biomedical ima data
Acknowledgments

National Alliance for Medical Image Computing
NIH U54EB005149

Neuroimage Analysis Center
NIH P41RR013218