Advanced visualization tools

NTA3

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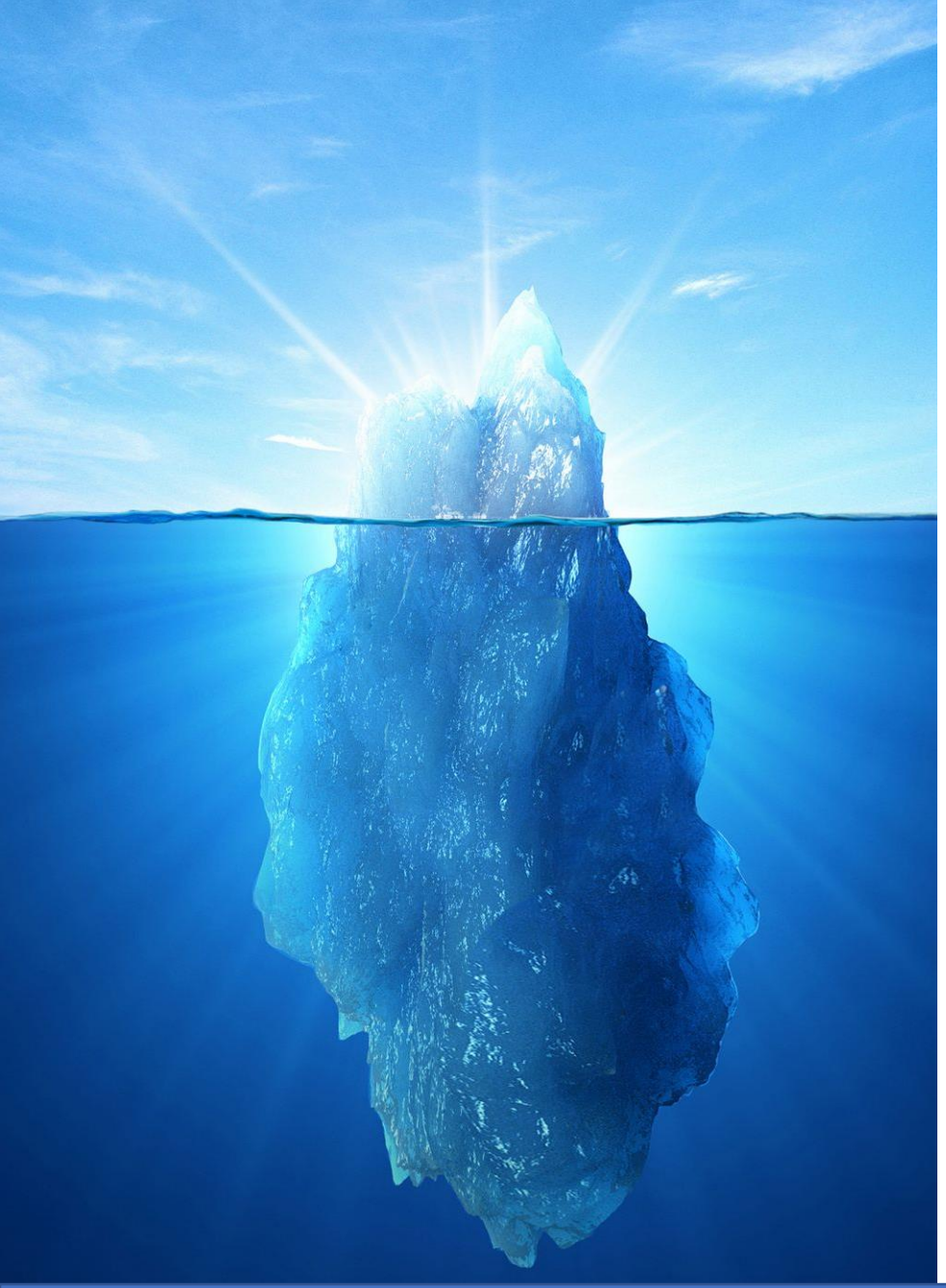
UNIVR - Altair Robotics Lab
NTA3 @ KU Leuven 24 -28 February 2020

UNIVERSITÀ di VERONA
Dipartimento di INFORMATICA

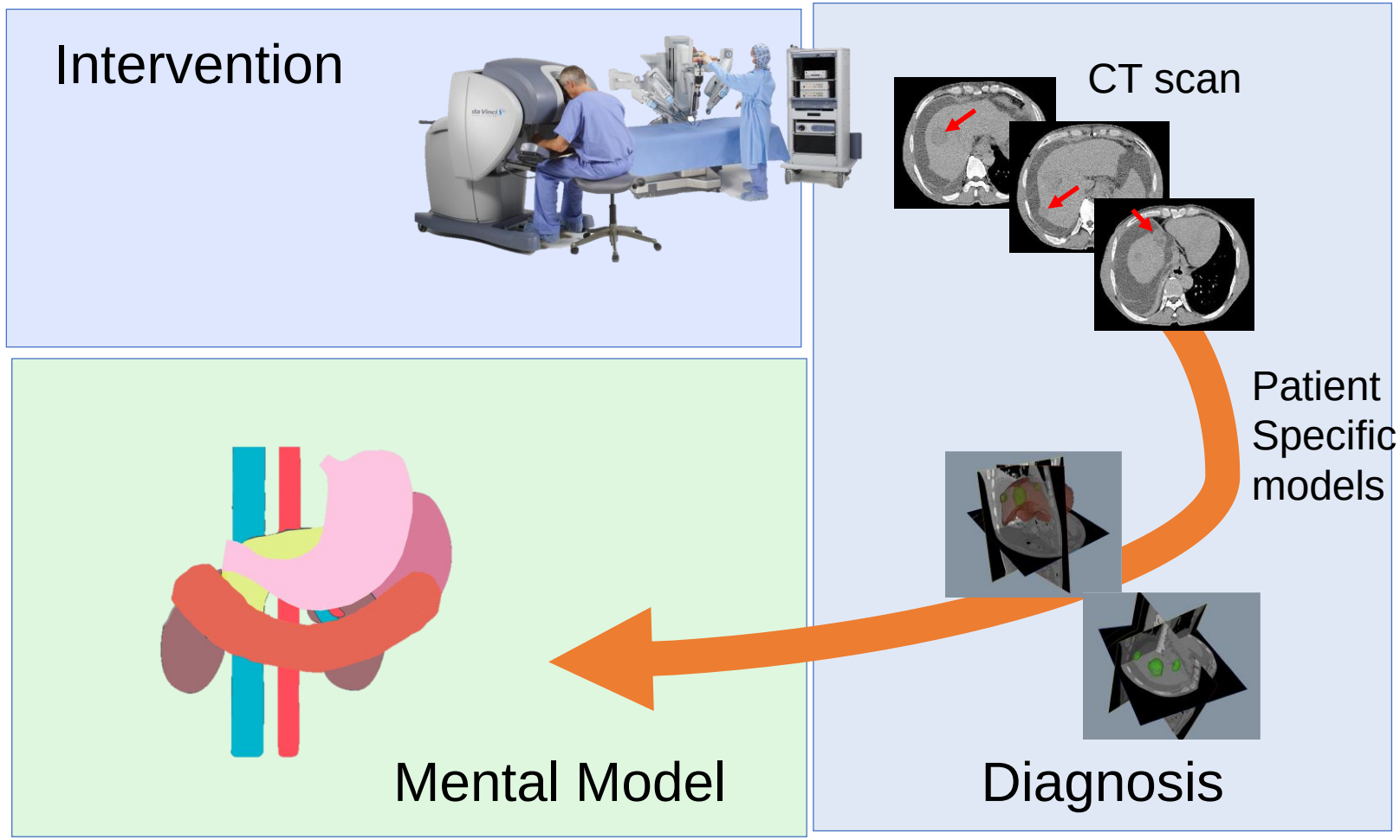


Overview

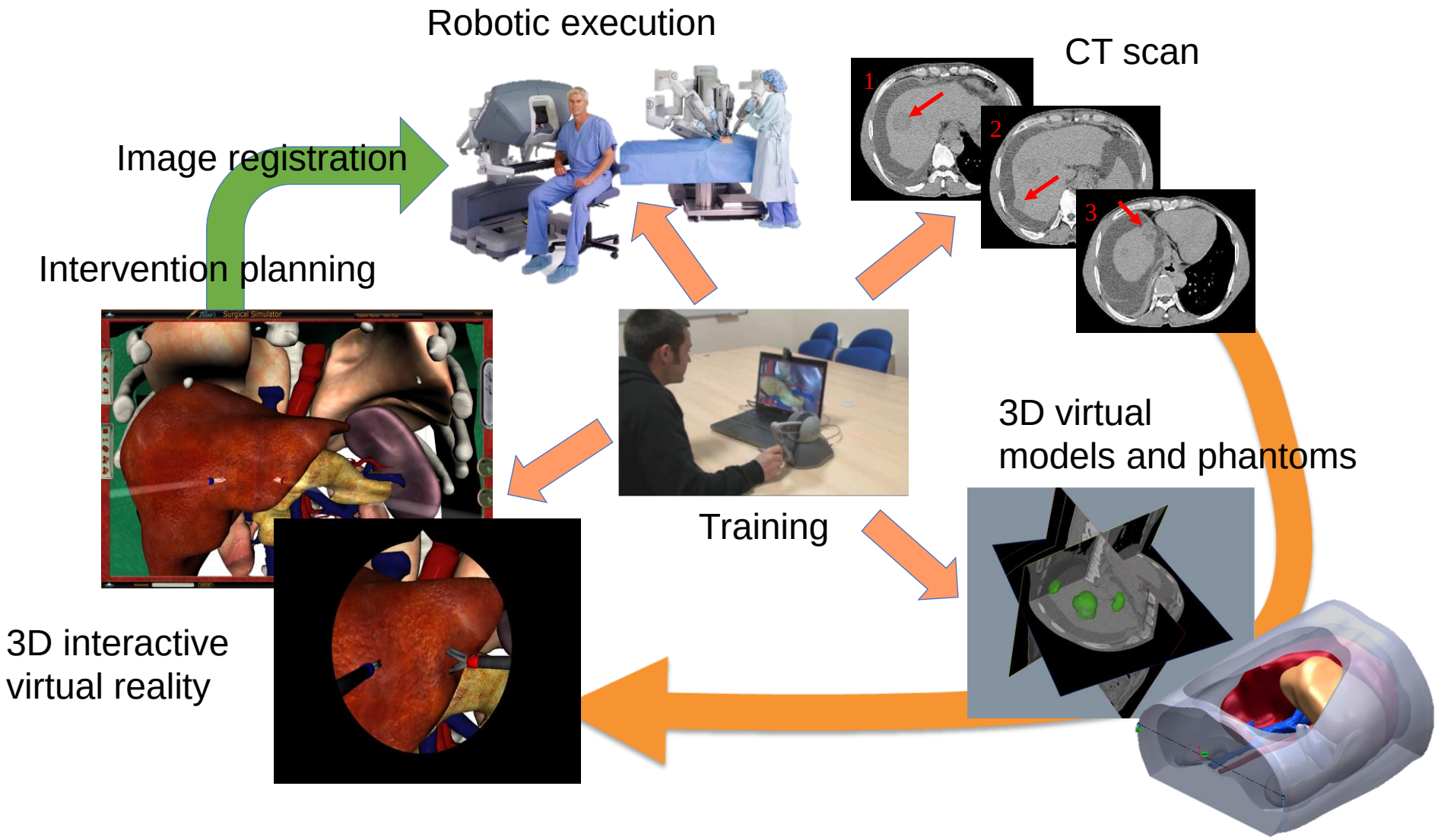
1. Workflow in robotic surgery
2. From pre-op data to 3d models
3. Advanced visualization tools

4. NTA4 Preliminary information

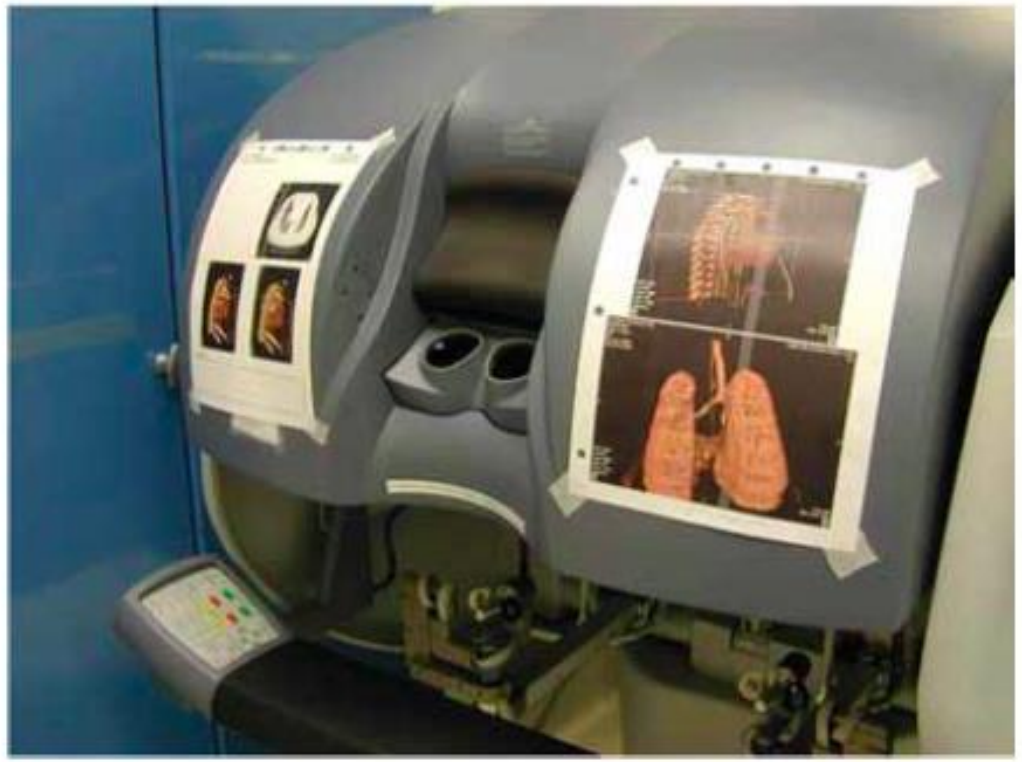
Workflow of robotic surgery



Ideal Workflow of robotic surgery

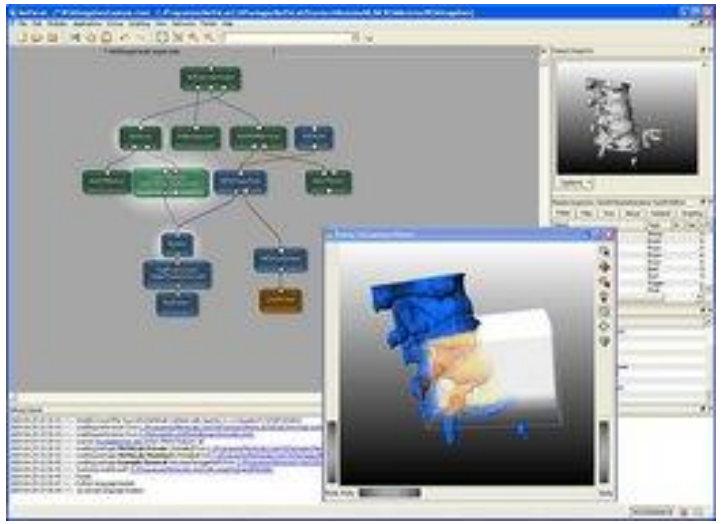


Information transfer in robotic surgery

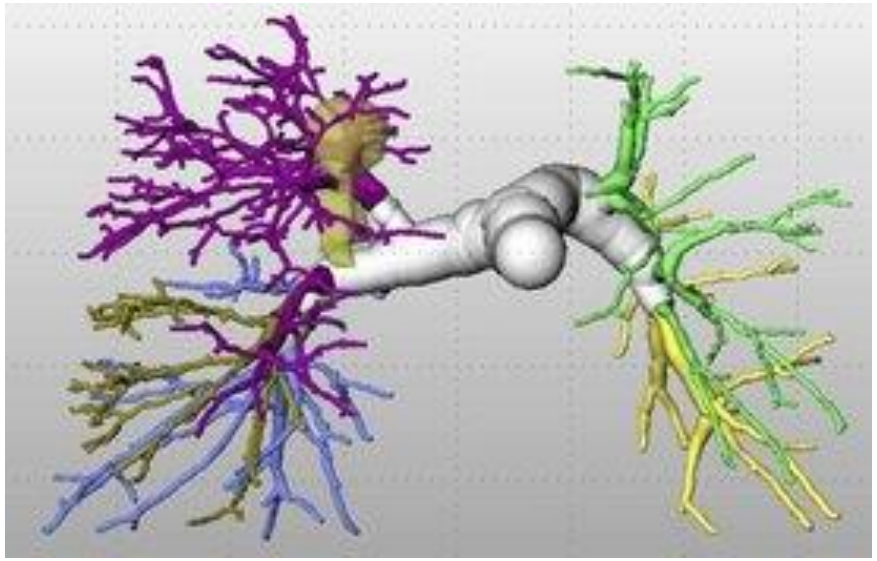


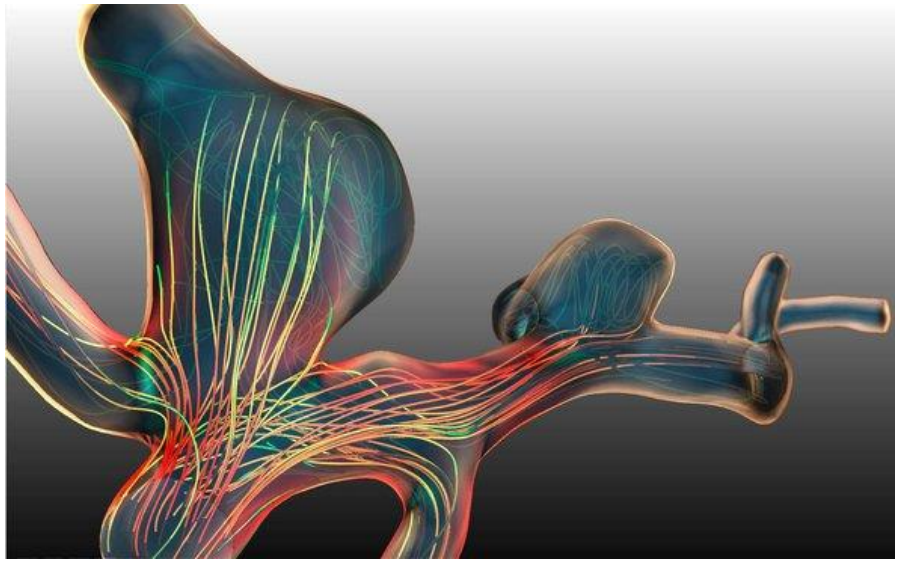
Pre operative Medical image processing tool example: MevisLab

- MeVisLab represents a powerful, modular framework for image processing research and development with a special focus on medical imaging.
- It allows fast integration and testing of new algorithms and the development of clinical application prototypes.
- MeVisLab includes advanced software modules for segmentation, registration, volumetry, as well as morphological and functional analysis.
- The implementation of MeVisLab makes use of Qt, the visualization and interaction toolkit Open Inventor, the scripting language Python, and the graphics standard OpenGL.



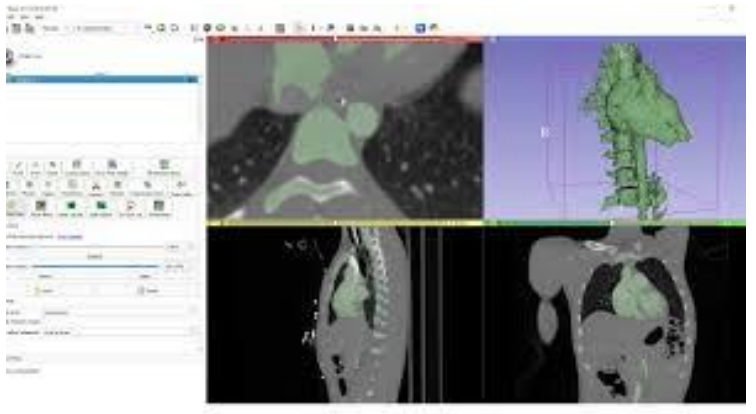
Mevislab example processing results



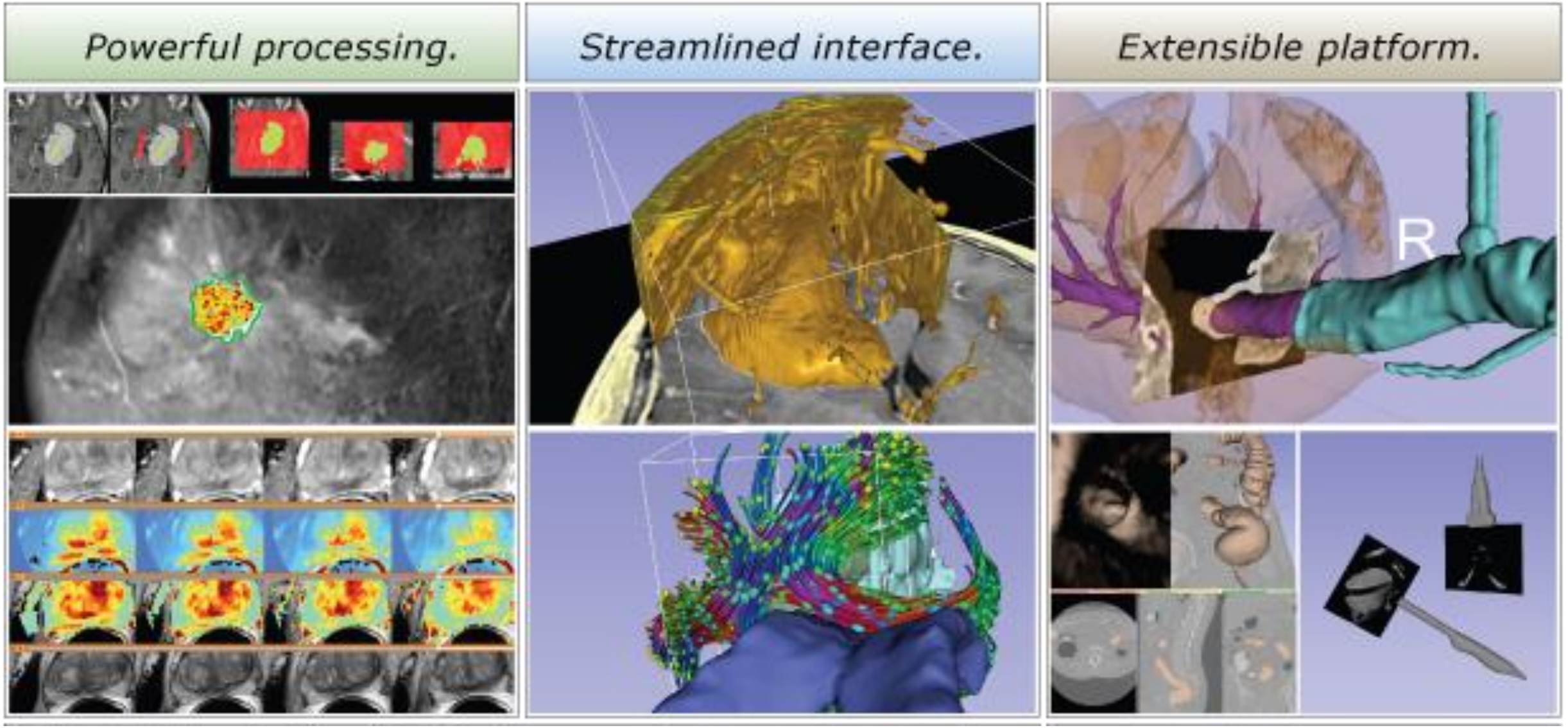


Medical image processing tool example: 3D Slicer

- A software platform for the analysis (including registration and interactive segmentation) and visualization (including volume rendering) of medical images and for research in image guided therapy.
- A free, open source software available : Linux, MacOSX and Windows
- Extensible, with powerful plug-in capabilities for adding algorithms and applications.
- Support for multi-modality imaging including, MRI, CT, US, nuclear medicine, and microscopy.
- Bidirectional interface for devices.
- There is no restriction on use, but Slicer is not approved for clinical use and intended for research.

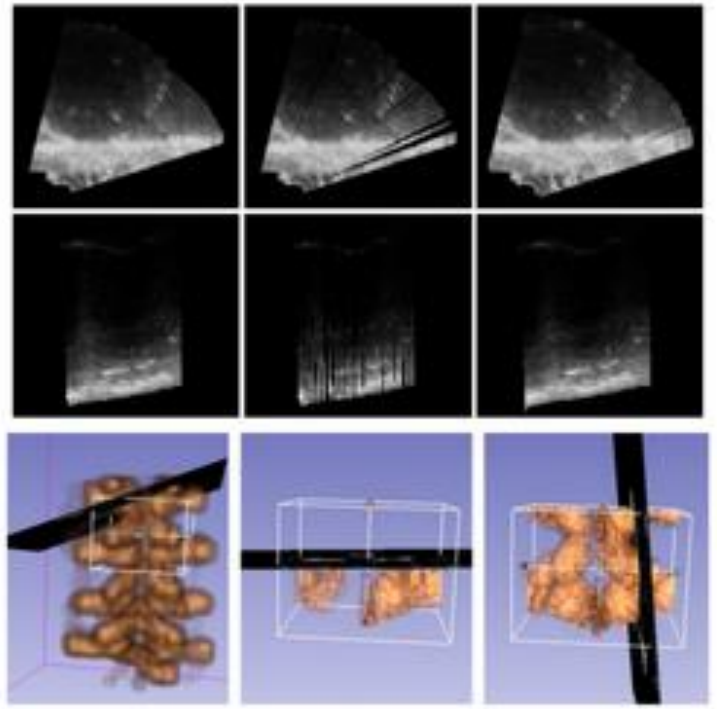


3D Slicer examples

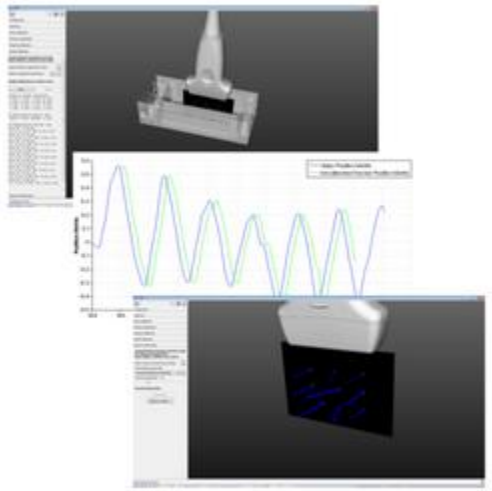


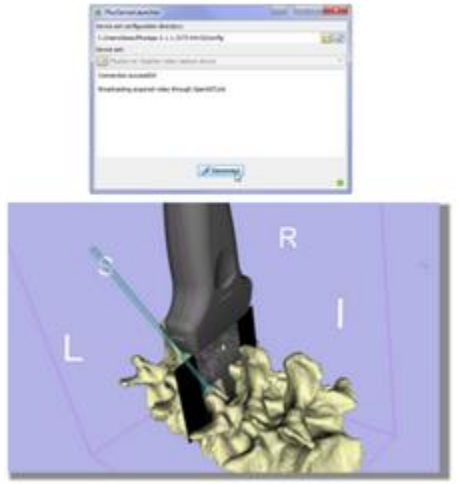
PLUS toolkit

- Plus is an open-source software toolkit for data acquisition, pre-processing, and calibration for navigated image-guided interventions.
- Plus was originally developed for ultrasound-guided interventions (hence the name, Plus - Public software Library for UltraSound imaging research) and it contains all essential functions for implementing tracked ultrasound systems.
- it is now widely used in all kind of interventions, with and without ultrasound imaging.

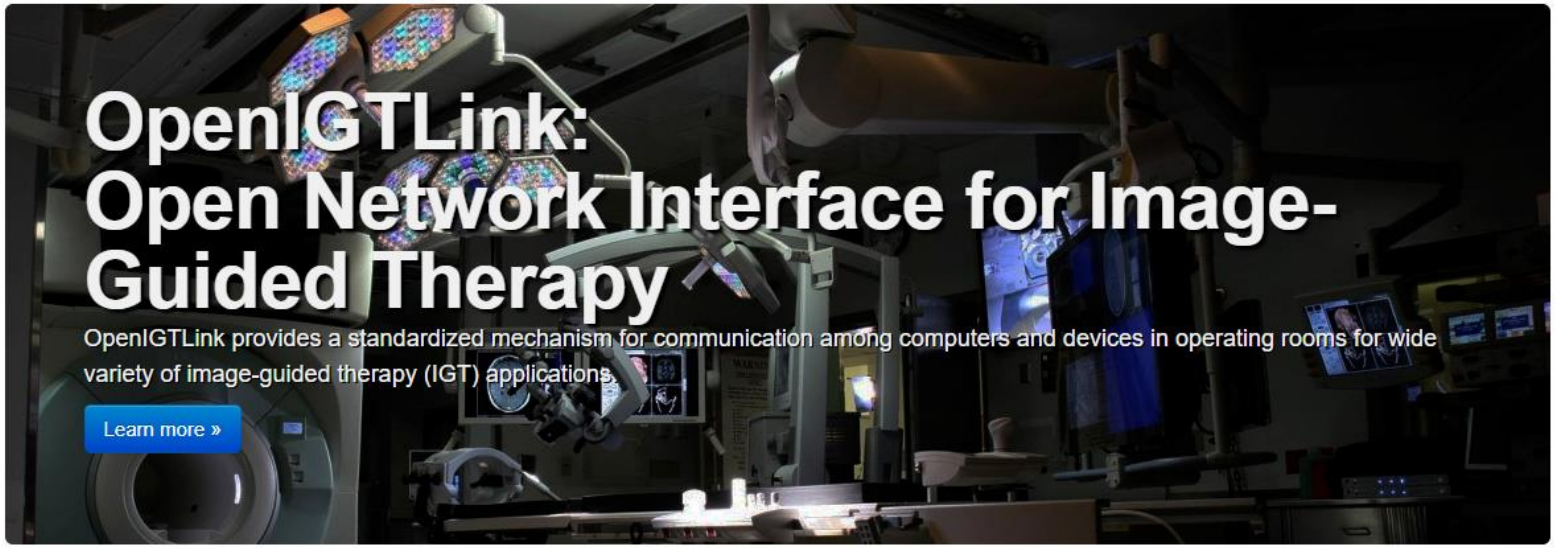


PLUS toolkit main features



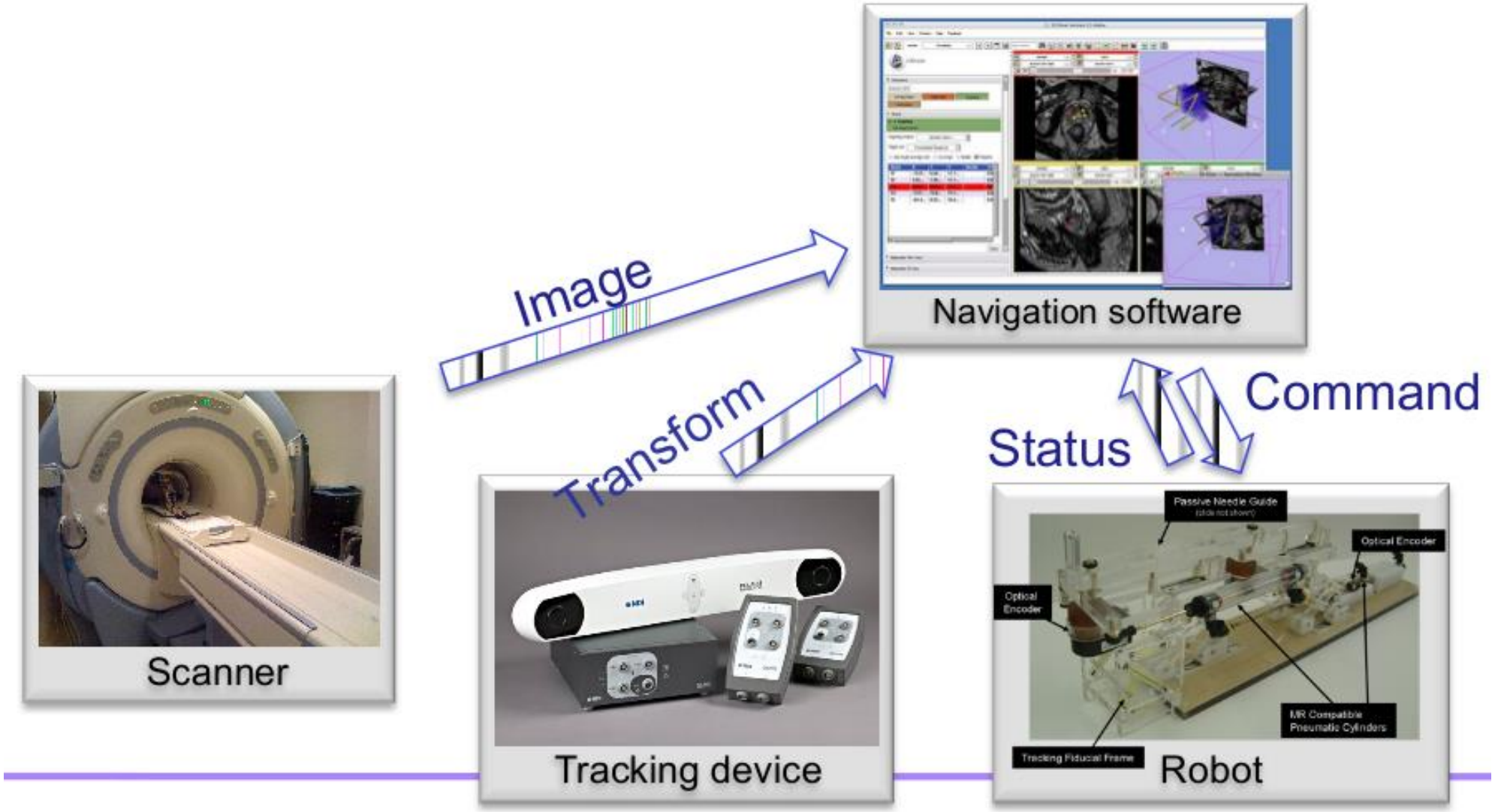


OpenIGTLink: communication protocol

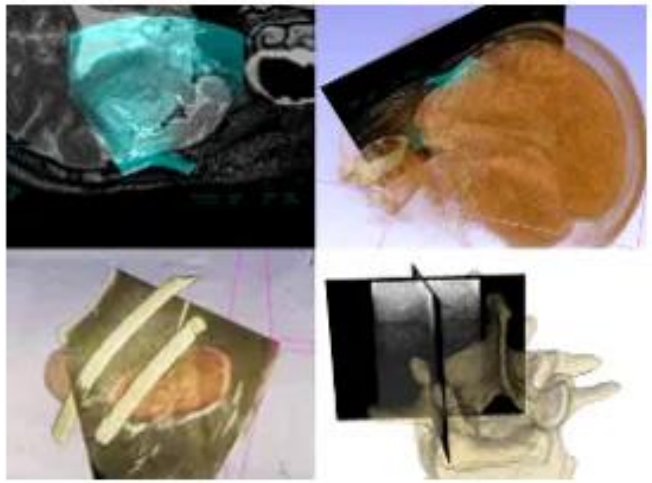


It is an open-source network communication interface specifically designed for image-guided interventions.
It aims to provide a plug-and-play unified real-time communications (URTC) in operating rooms (ORs) for image-guided interventions, where imagers, sensors, surgical robots,and computers from different vendors work cooperatively.
This URTC will ensure the seamless data flow among those components and enable a closed-loop process of planning, control, delivery, and feedback.
The specification of OpenIGTLink is open, and can be used without any license fee; hence OpenIGTLink is suitable for both industrial and academic developers.

OpenIGTLink: Application architecture



OpenIGTLink + Slicer = SlicerIGT ☺



```
vtkCollection* sliceNodes = this->GetMRMLSc
vtkCollectionIterator* sliceIt = vtkCollecti
sliceIt->SetCollection( sliceNodes );
sliceIt->InitTraversal();
for ( unsigned int i = 0; i < sliceNodes->G
{
  vtkMRMLSliceNode* sliceNode = vtkMRMLSlic
  sliceIt->GoToNextItem();
  const char* driverCC = sliceNode->GetAttr
  if (    sliceNode != NULL
       && driverCC != NULL
       && calleeNodeID.compare( std::string
  {
    SlicesToDrive.push_back( sliceNode );
  }
```

Builds on a dynamic platform

SlicerIGT is an extension of 3D Slicer, a free, open source software for visualization and image analysis. SlicerIGT can be installed from the 3D Slicer Extension Manager on Windows, Mac, and Linux to use all the advanced features of 3D Slicer for real-time navigation.

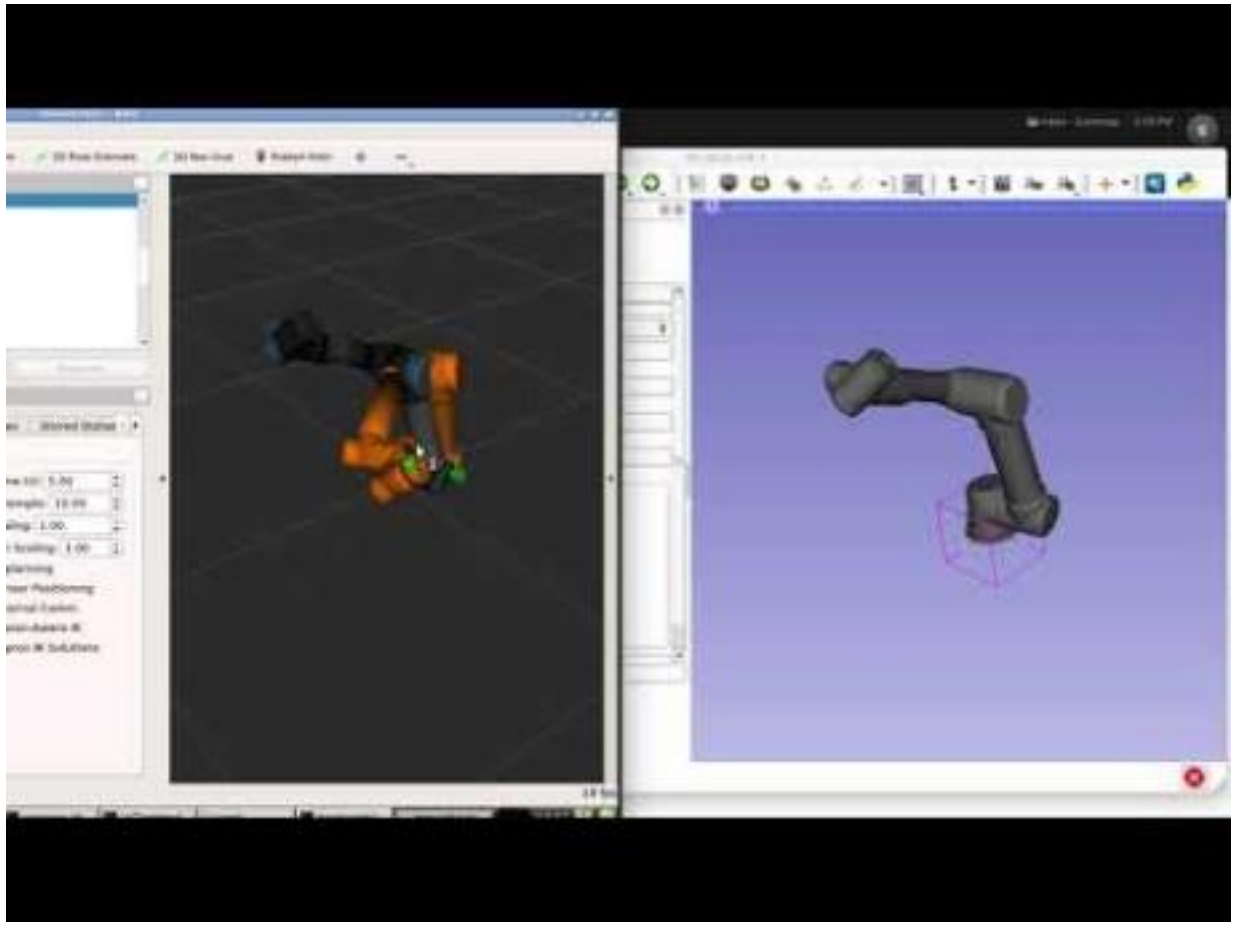
Development without coding

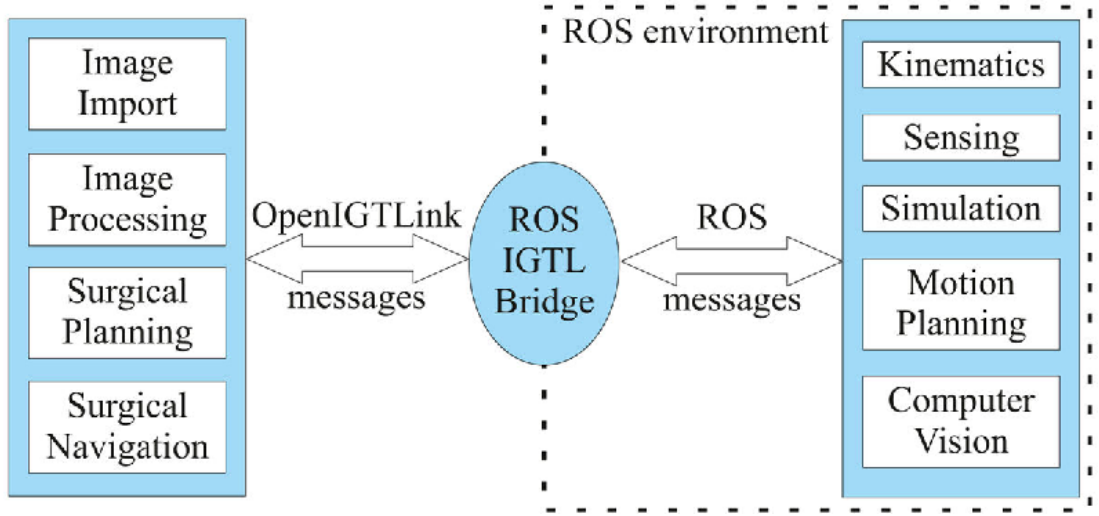
Modules of SlicerIGT are designed so you can configure a procedure-specific application without programming, or with minimal scripting. We have configured SlicerIGT to support many procedures including brain surgery, urology, regional anesthesia, and more...

SlicerIGT is open

Our development and research work is public, including source code, data, experiment protocols, manuals, etc. SlicerIGT is distributed under the BSD-style Slicer license allowing academic and commercial use without any restrictions.
Visit SlicerIGT on GitHub.

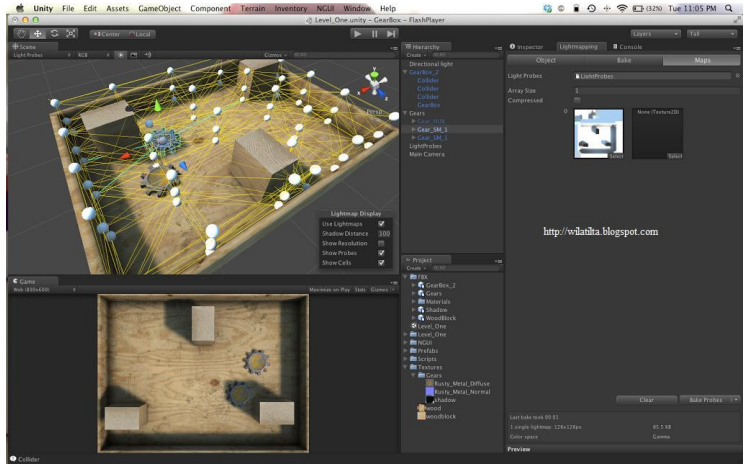
OpenIGTLink + ROS = ROS-IGTL-Bridge





Unity3D

- The Unity game engine launched in 2005, aiming to "democratize" game development by making it accessible to more developers.
- Unity gives users the ability to create games and experiences in both 2D and 3D,
- the engine offers a primary scripting API in C#, for both the Unity editor in the form of plugins, and games themselves, as well as drag and drop functionality.
- Unity is a cross-platform engine
- The Unity editor is supported on Windows and macOS, with a version of the editor available for the Linux platform, albeit in an experimental stage
- While the engine itself currently supports building games for more than 25 different platforms, including mobile, desktop, consoles, and virtual reality
- As of 2018, Unity has been used to create approximately half of the new mobile games on the market and 60 percent of augmented reality and virtual reality content.



Unity3D Editor Interface

ROS# is a set of open source software libraries and tools in C# for communicating with ROS from .NET applications, in particular Unity.

ROS# is developed for Windows and has successfully been used on a variety of other platforms community members.

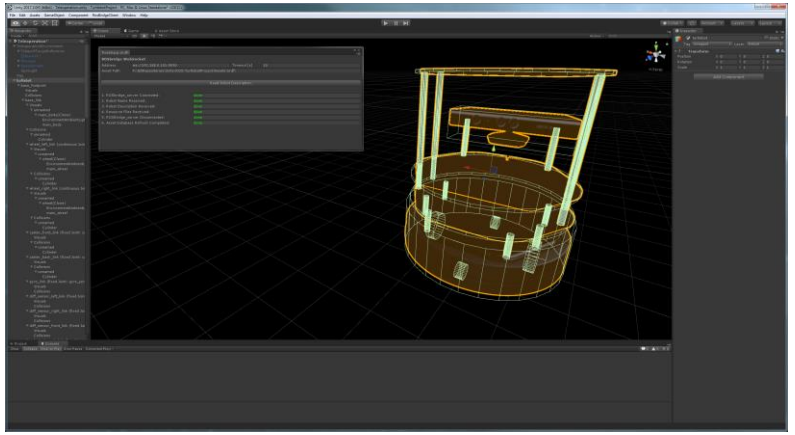
ROS# has been originally developed by SIEMENS!

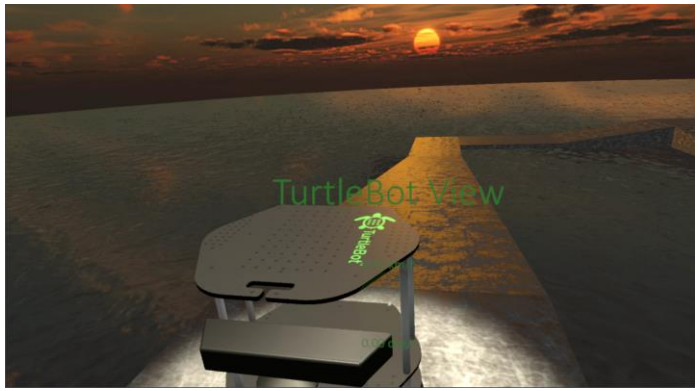
Features description available at: https://github.com/siemens/ros-sharp/wiki/Info_Showcases

Unity + ROS = ROS#

ROS# helps you to:

- communicate with ROS from within your Windows Application, including subscribe and publish topics, call and advertise services, set and get parameters
- import your robot's URDF model as a Gameobject in Unity
- control your real Robot via Unity
- visualize your robot's actual state and sensor data in Unity
- simulate your robot in Unity with the data provided by the URDF and without using a connection to ROS. Beside visual components as meshes and textures, also joint parameters and masses, centers of mass, inertia and collider specifications of rigid bodies are imported and used for the physical simulation in Unity
- train neural networks e.g. in combination with Unity's ML Agents





NTA4: 3D tissue segmentation, modelling and deformation

From Monday July 20th 2020 to Friday July 25th 2020

First 3 days in Milan → Last 2 days in Verona

Main sites of Corona virus infections ☺

NTA4 preliminary program

Day	Morning	Afternoon
Monday July 20th	Tutorial on 3D Image registration and segmentation (Bogdan - UNIVR) Tutorial on DL for 3D image segmentation and classification (Aldo - POLIMI)	Hands-on on tools for 3D image processing (Aldo) Project assignment
Tuesday July 21st	Tutorial on endoscopic image processing (Sara - POLIMI) Tutorial on DL for tool/ tissue segmentation and tracking (Danail - UCL)	Hands-on on tools for endoscopic image processing (Sara)
Wednesday July 22nd	Anatomical Self Localization and Mapping (Andrea - UNIVR) Tutorial on 3D modelling (Eleonora - univr)	*Transfer to Verona*
Thursday July 23rd	Sofa tutorial on bio-mechanical soft tissue simulation (Hugo – Sofa Cons.)	Hands on session with SOFA (Hugo and eleonora)
Friday July 24th	Time for project implementation	Project presentation

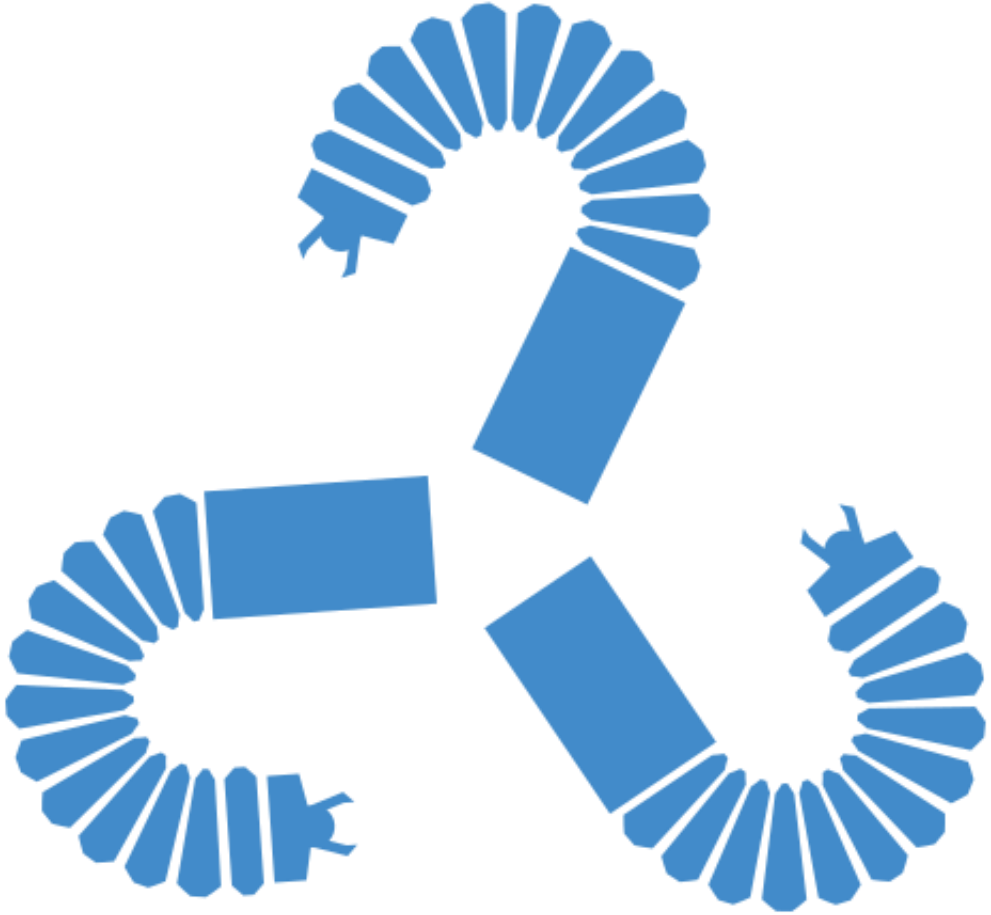
NTA4 preliminary social activities

Social Dinner in Milan on Tuesday Evening

Opera Night in Arena di Verona on Friday Evening

Many other "informal" social event in Milan or on the Garda Lake the weekend before and after the school ☺

Questions?



For more information please write to: diego.dallalba@univr.it