EIBIR presents IMAGINE

After last year's success, EIBIR is again hosting the IMAGINE Workshop, under the heading 'Novel technology that shapes radiology'. IMAGINE aims to stimulate interaction between imaging researchers and radiologists. Leading international academic and industrial research groups present their latest developments in medical image analysis and image-guided interventions. During the interactive software demonstration sessions the visitors get hands-on experience with developed techniques and tools. The presenters of the workshops were invited to introduce their work in ECR Today.

SlicerRT sets new standard for radiation therapy research tools

By Csaba Pinter, Andras Lasso, An Wang, David Jaffray, and Gabor Fichtinger

Recent years have seen a growing interest in adaptive radiation therapy (RT) research, and yet the available software tools do not reflect this tendency. The commercial applications are not only expensive, but typically cover only routine clinical procedures, and offer very limited flexibility and extensibility. On the other hand, the available open-source packages fall short in terms of limited scope, reliability, user support, lack of documentation, or dependency on commercial software packages (such as MATLAB).

Our research team, funded by Cancer Care Ontario and the Ontario Consortium for Adaptive Interventions in Radiation Oncology (OCAIRO, a diverse community covering over twenty RT research groups in Ontario, Canada), proposed to develop an RT research platform that overcomes these challenges.

As a result of extensive and coordinated long-term efforts, 3D Slicer has emerged as a widely used platform for medical image computing and image-guided interventions. Its extensibility, built-in algorithms, and extensive documentation, along with its visualisation, scripting and data handling capabilities make it a natural choice of platform for an RT research toolkit. Our SlicerRT toolkit thus builds on 3D Slicer, leveraging its flexible plug-in mechanism to provide additional features needed for RT research. Its feature set was defined through consensus discussions with a large pool of RT researchers, including both radiation oncologists and medical physicists from OCAIRO.

The RT-specific features include loading DICOM-RT data, handling various structure set contour representations, computing and displaying dose-volume histograms, creating accumulated dose volumes, comparing dose volumes and contours, visualising isodose lines and surfaces (Figure 1), performing morphological operations on contours, and registering images using multistage B-spline deformable registration or landmark deformable registration. The imported images, dose maps and structure sets are represented as standard 3D Slicer data objects, therefore the large number of already existing 3D Slicer modules are all usable for the analysis, processing, and visualisation of RT data.

The underlying algorithms are either implemented utilising the libraries already used by 3D Slicer for visualisation (VTK) and image processing (ITK), or provided by the Plastimatch library (plastimatch.org). The architectural details are described in an article recently published in *Medical Physics*[1].

1 Pinter, C., A. Lasso, A. Wang, D. Jaffray, and G. Fichtinger, 'SlicerRT – Radiation therapy research toolkit for 3D Slicer', Medical Physics, vol. 39, issue 10, pp. 6332/7, 10/2012

An example of the use of the SlicerRT package is the evaluation of the effectiveness of RT plan adaptation techniques. The goal is to simulate and assess different types of adaptation methods for multiple-fraction external beam radiation therapy treatment cases. One of these is the isocenter shifting technique, which optimises the dose delivered to the target volume and the organs at risk by physically moving the isocenter. The 3D Slicer's built-in rigid registration and resampling modules are used to align the planning and daily anatomy images, and then a SlicerRT module is used to accumulate the delivered daily doses. The other technique uses deformable registration to simulate online re-planning, which is also part of the 3D Slicer repertoire. Next, the dose-volume histogram (DVH) for the accumulated dose distributions is computed using a SlicerRT module for the original case without adaptation, the isocenter shifting case, and the online re-planning case. The DVH curves can be displayed for the target volumes for visual assessment (Figure 2). To quantify the results, the D90 metric is computed for the target volume, and the D1 and D99 metric for the organs at risk.

SlicerRT has been developed following software development processes that have already proved to work well for 3D Slicer, thus ensuring software quality. The source code and test data are openly available. The project has a wiki page, which contains detailed guides for users and developers, as well as information about events and meetings (www.assembla.com/spaces/slicerrt). The SlicerRT functions are automatically tested on various operating systems every night, identifying potential regressions by reporting the test results on a dashboard system. SlicerRT and 3D Slicer are distributed under a BSD-style open-source license. The software may be used not only for research purposes but also for clinical and commercial projects.

The SlicerRT extension is supported on Windows, Mac, and Linux operating systems. To get started download and install 3D Slicer from www.slicer.org, then use its built-in extension manager to download and install the SlicerRT extension.

As current funding ensures further development for several years, SlicerRT will foreseeably evolve further, incorporating new features and integrating closer with other tools. We also expect that other research groups will join these efforts.

The current version of the toolkit will be presented at the IMAGINE Workshop presented by the European Institute for Biomedical Imaging Research (EIBIR). The project will be showcased on Saturday, March 9, 14:00–15:30 in the EIBIR IMAGINE Theatre next to room U on the second level.

The accompanying poster to this presentation is published in EPOS™ and can be accessed online at myESR.org/EPOS. The poster (*X-NNNN*) is titled 'SlicerRT – Radiation therapy research toolkit for 3D Slicer'.

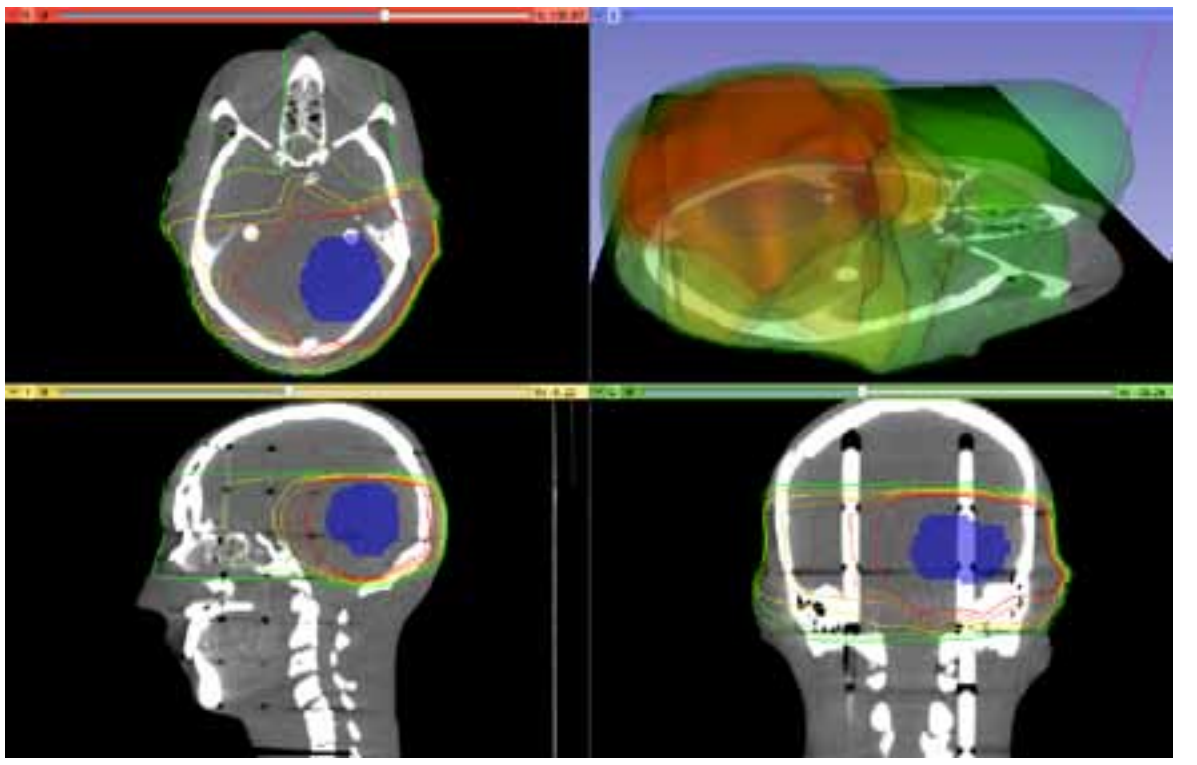

Figure 1: Isodose lines and surfaces created by SlicerRT shown in a standard 3D Slicer scene.

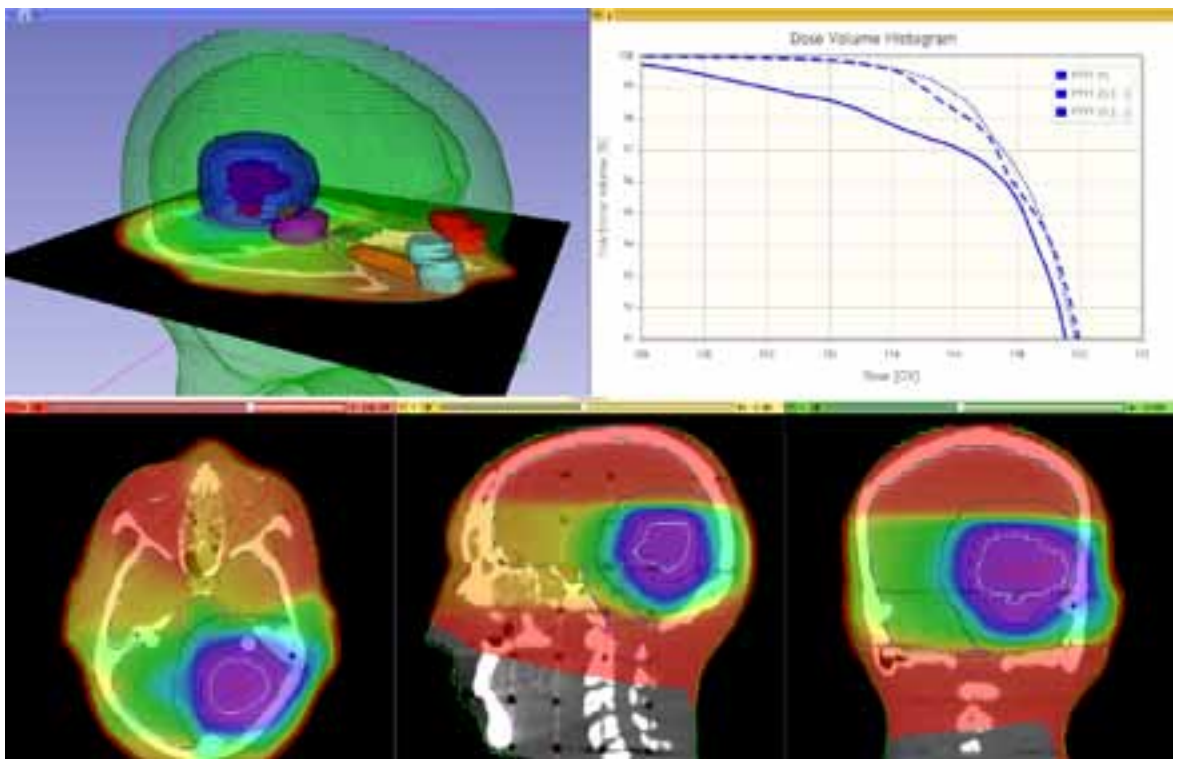

Figure 2: Comparison of dose escalation results in SlicerRT. The upper right view shows the 3D models created from the contoured structures (targets, organs at risk), intersected by the same axial slice shown in the bottom left viewer. The DVH plots in the upper right corner show the difference between the delivered total doses to the target volume using the three techniques (solid: no registration; dashed: rigid registration; dotted: deformable BSpline registration).

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