UT Southwestern Medical Center
Radiation Oncology

Development of an Imaging and Treatment Planning System for Small Animal Radiation Research

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INTRODUCTION

Our laboratory is in the process of building a new small animal irradiator with new features such as dual-energy cone beam CT functional imaging (PET) based image guidance, intensity modulated radiation delivery (IMRD) via a rectangular jaw collimator, a fast GPU-based Monte Carlo (MC) dose calculation. To support this new irradiator, we have developed a new imaging and treatment planning system (ITPS). The end-users can use this system to achieve major functions in treatment planning and quickly generate high quality plans.

METHOD

- ITPS was developed in C++, together with Qt and VTK
- Interface: 3D orthogonal views of anatomical structure, contours, and dose distribution, and DVH, beam placement
- Dose calculation: An in-house developed MC package goMC was used for dose calculations
- Forward planning: the user can define isocenters, beam angles, and collimator sizes
- Inverse planning: achieved by solving an optimization problem seeking for a series of rectangular apertures and corresponding beam-on time, as well as the most efficient delivery sequence for each beam angle
- Source validation: compared measured and calculated percentage depth dose (PDD)

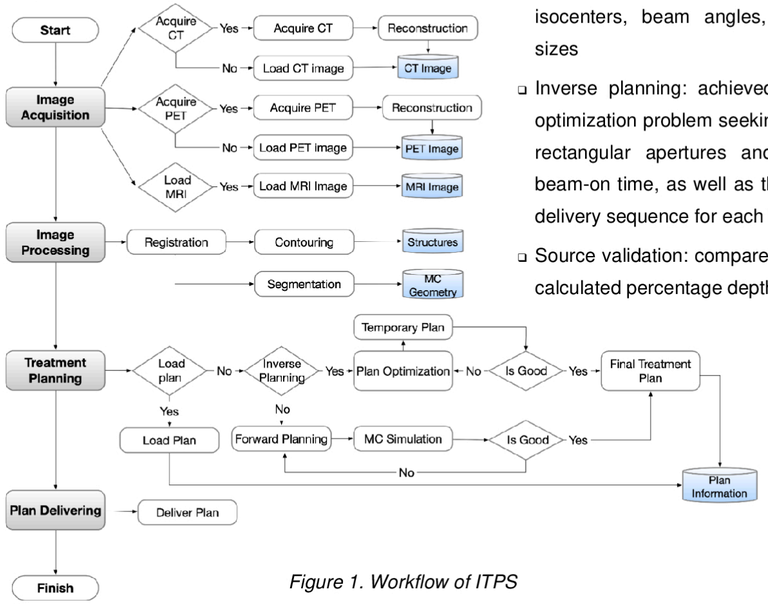

Figure 1. Workflow of ITPS

RESULTS

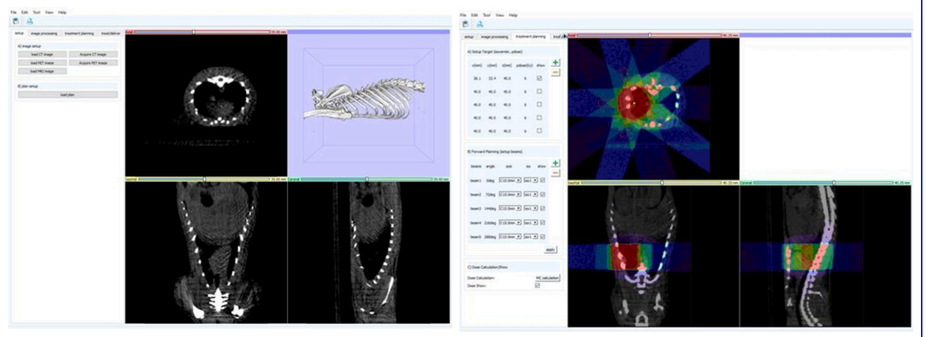

Figure 2. Imaging and planning interface of ITPS

Fig. 2, Fig. 3 and Fig. 4 show the ITPS interface, inverse planning results, PDDs comparison, respectively.

- The end-users can smoothly navigate through the ITPS for different functions and generate a plan.
- When IMRD plan and cone-based plan were normalized to the same target coverage, OARs are spared much more effectively in IMRD plans. Average dose can be reduced for OAR in water phantom case, lung in mouse case by 25.3%, 13.9%, respectively.
- The measured and calculated percentage depth dose agreed within 1.5% for the 40 mm square, 10 mm circular, 5 mm circular collimators at all depths.

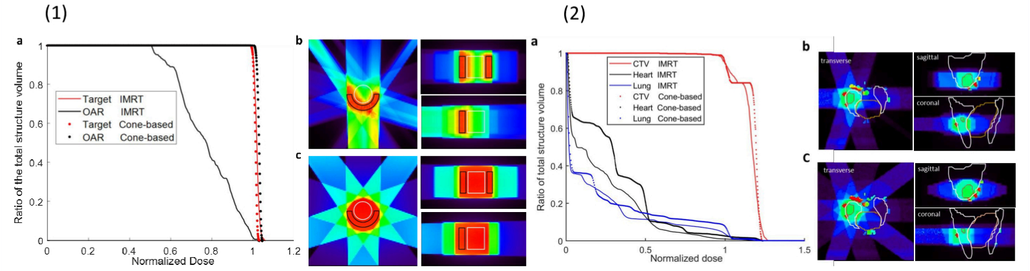

Figure 3. . Inverse planning results of the water phantom case (1) and mouse cases (2): (a) DVH comparison, (b)-(c) Dose distribution of IMRT plan and cone-based plan. Contours indicate the target and OARs.

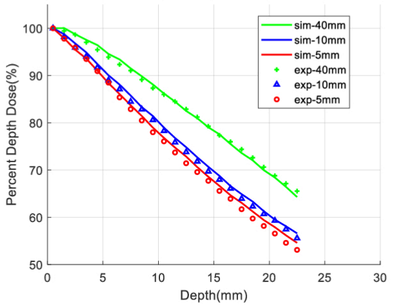

Figure 4. Measured and calculated PDDs comparison

CONCLUSION

We developed a dedicated ITPS for a new small animal irradiator currently under construction. Its use is expected to facilitate pre-clinical animal irradiation studies.

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