3D Visualization Tool for IMPT Planning

Meng Wei Ho, Zuofeng Li
UF Health Proton Therapy Institute, USA

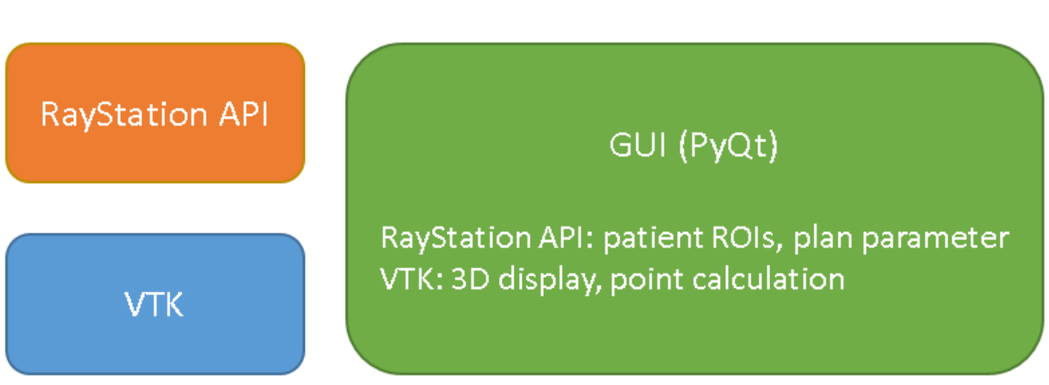
Objectives

To develop a 3D visualization scripting tool in TPS to quickly check potential collisions and calculate air gap for each pencil beam spot between range shifter and skin surface.

Methods and Materials

User interface (PyQt) of the scripting tool is composed of a single 3D display window, together with editable beam parameters, such that alternative beam parameters may be manually entered or load from TPS to evaluate their effects on collision avoidance and air-gap reduction.

An open source, Visualization Toolkit (VTK), was used in Python script in RayStation. The visualization pipelines include system components (such as the distal aspect of the nozzle, snouts, range shifters, tabletops/inserts, and imaging system panels and tubes), patient plan structure ROIs (3D stl files generates through RayStation script), and plan parameters (isocenter, beam angle, couch angle, snout position, and spot information acquire from RayStation script).



An implicit class function in VTK (vtkImplicitPolyDataDataDistance) computes the distance between system components (ex. Range shifter) and patient external contour to detect collision. And another bounding box tree class function (vtkOBBTree) was used to perform intersection between all 3D objects along source position and spot (ray tracing) to calculate air gap between range shifter and body surface for each spot on the beam.

A threshold value was set to give user warning if the air gap exceeds it. Users are able to adjust machine parameter in TPS through script GUI if anything needs to be changed.

Result

For a given treatment plan open in TPS, the script was able to use to extract treatment field parameters and construct a geometric model of the delivery system in 3D view with fast rendering speed. Any parameter update can also get quick result.

Conclusions

The scripting tool achieves a level of integration with the TPS to give user additional information for beam design and plan optimization. The tool has been implemented and tested in the TPS and the proton therapy systems used at the authors' institution.

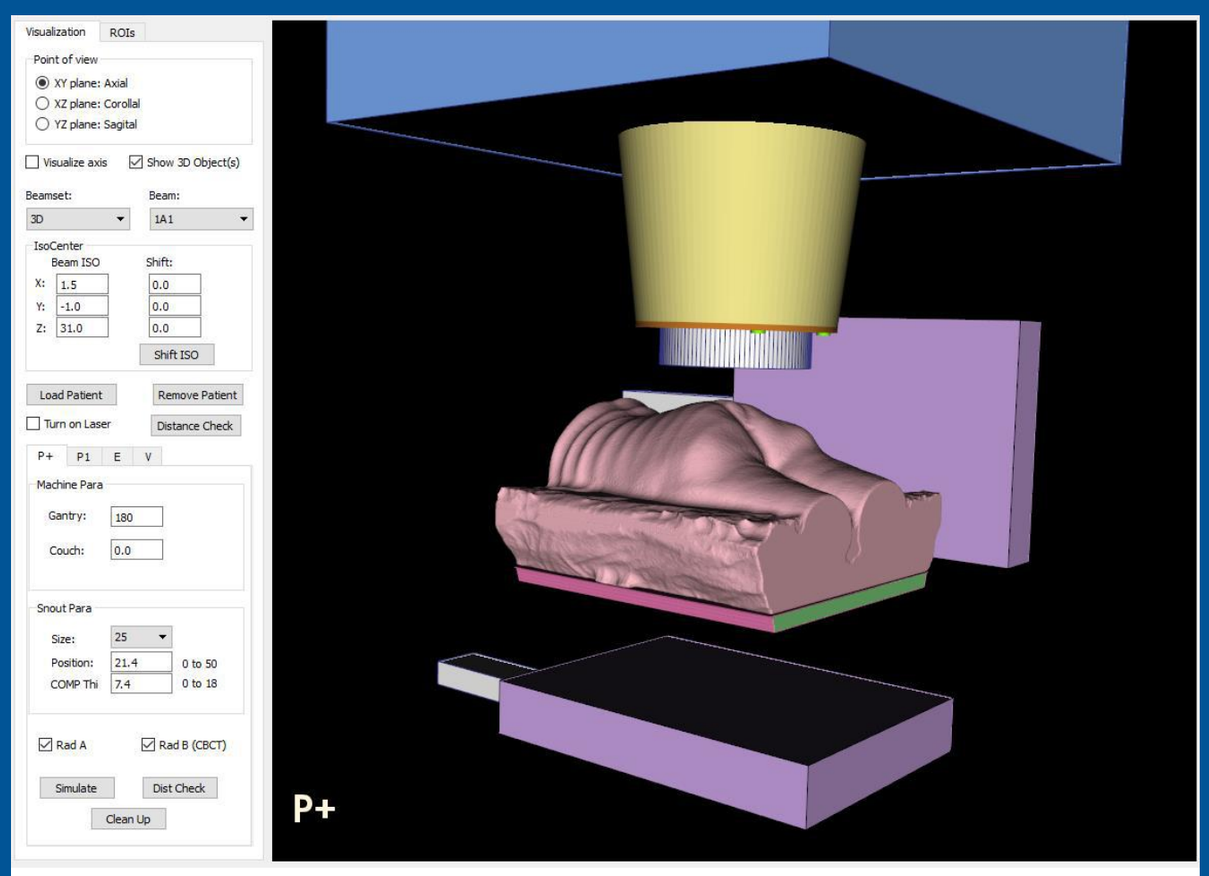


Figure 1: GUI interface for the scripting

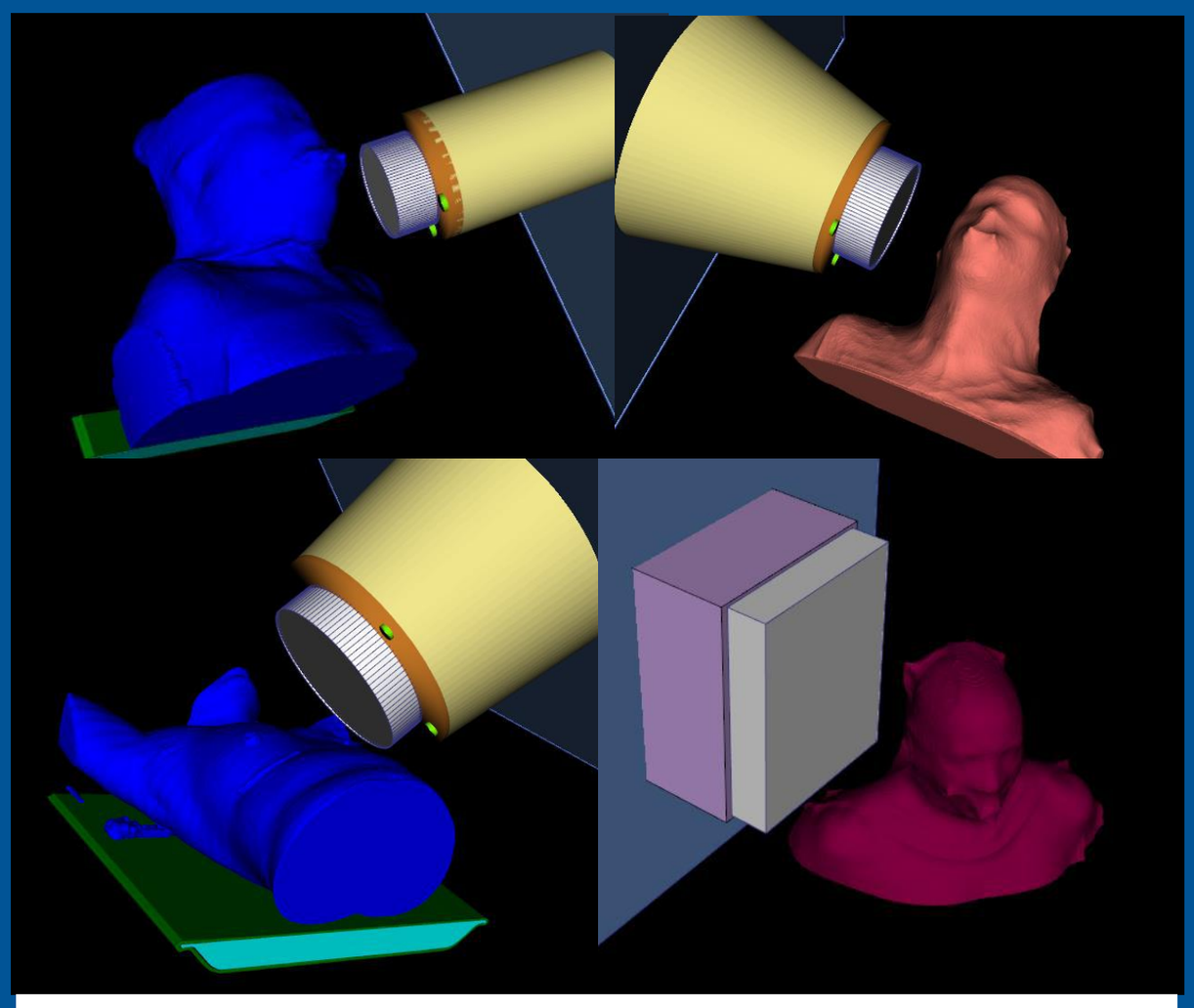


Figure 2: 3D display of machine (snout) and patient ROIs

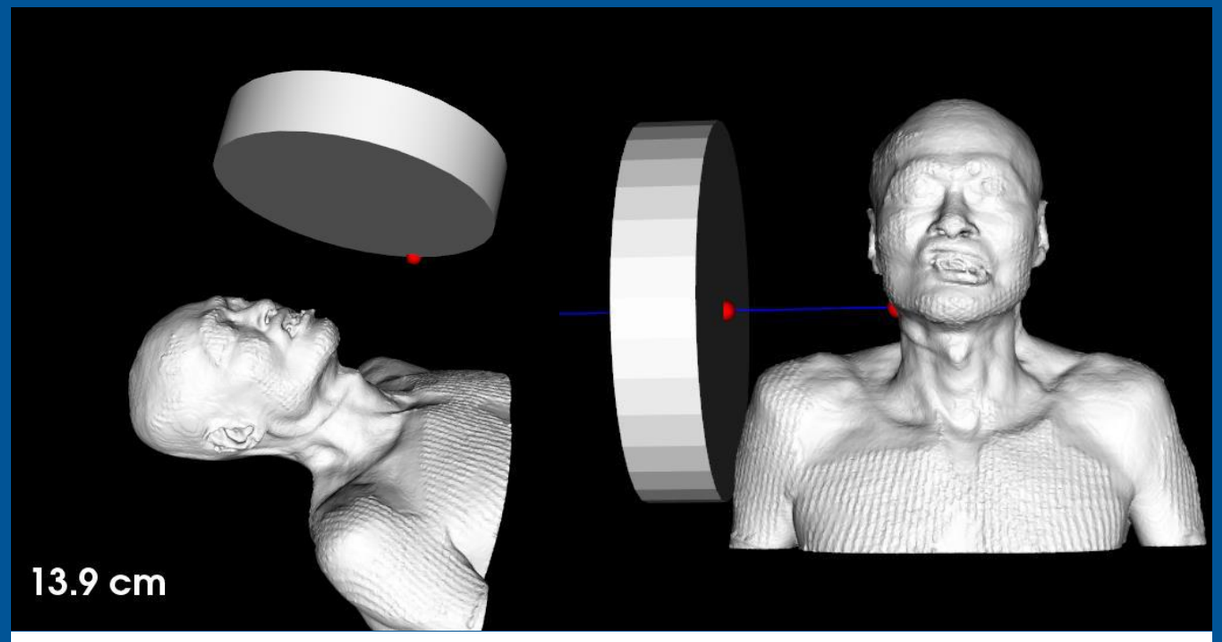


Figure 3: Result of distance calculation for collision check (left) and spot air gap (right).

Contact: mho@floridaproton.org