An Open-Source Tool to Visualize Potential Cone Collisions While Planning SRS Cases

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Background & Aims

To create an open-source visualization program that allows one to find potential cone collisions while planning stereotactic radiosurgery cases. In clinical settings it is necessary to be both precise and efficient. In the past, collisions lead to replanning of full SRS cases. By creating this program, one can increase the efficiency of treatment planning and assure no collisions once in the treatment room.

Methods & Materials

Measurements of physical components in the treatment room (gantry, cone, table, localization SRS frame, etc.) were incorporated into a set of scripts in MATLAB (MathWorks, Natick, MA) that produce 3D visualization of the components. This software was also refined so that it works within the free alternative to MATLAB, GNU Octave. The localization frame fully contains the patient so it was used to represent the patient safety zone. To approximate simulated components graphically, all elements were created as either a cylinder, a box or ellipsoid. The gantry head and cone were made from cylinders. The patient safety zone could be made from either an ellipsoid or box. The treatment couch was made from two boxes (see Figs. 1, 2, and 3). The equations used to create the boxes allowed for accurate representation of motion in a treatment room and related all motion to the machine isocenter. It allowed for the target to be moved in the three translation directions, the couch to be changed by 180 degrees, and for the gantry to move a full 360 degrees.

A simple graphical user interface (GUI) was made in MATLAB to allow users to pass the target coordinate (vert, lat, long) relative to the localization frame, the initial and terminal gantry and couch angles, and the number of angular points to visualize between the initial and terminal gantry angle. All known clinical cases resulting in collisions during the software development time (three cases) were tested to confirm that the program could replicate the scenario.

Results

The software provides a fast and simple way to discover collisions in the treatment room before the treatment plan is completed. By inputting the treatment isocenter, gantry angle and couch angle, the program shifts the localization box to the appropriate location and provides a visual of the gantry throughout the treatment. The cases tested showed collisions when there were indeed collisions in the room.

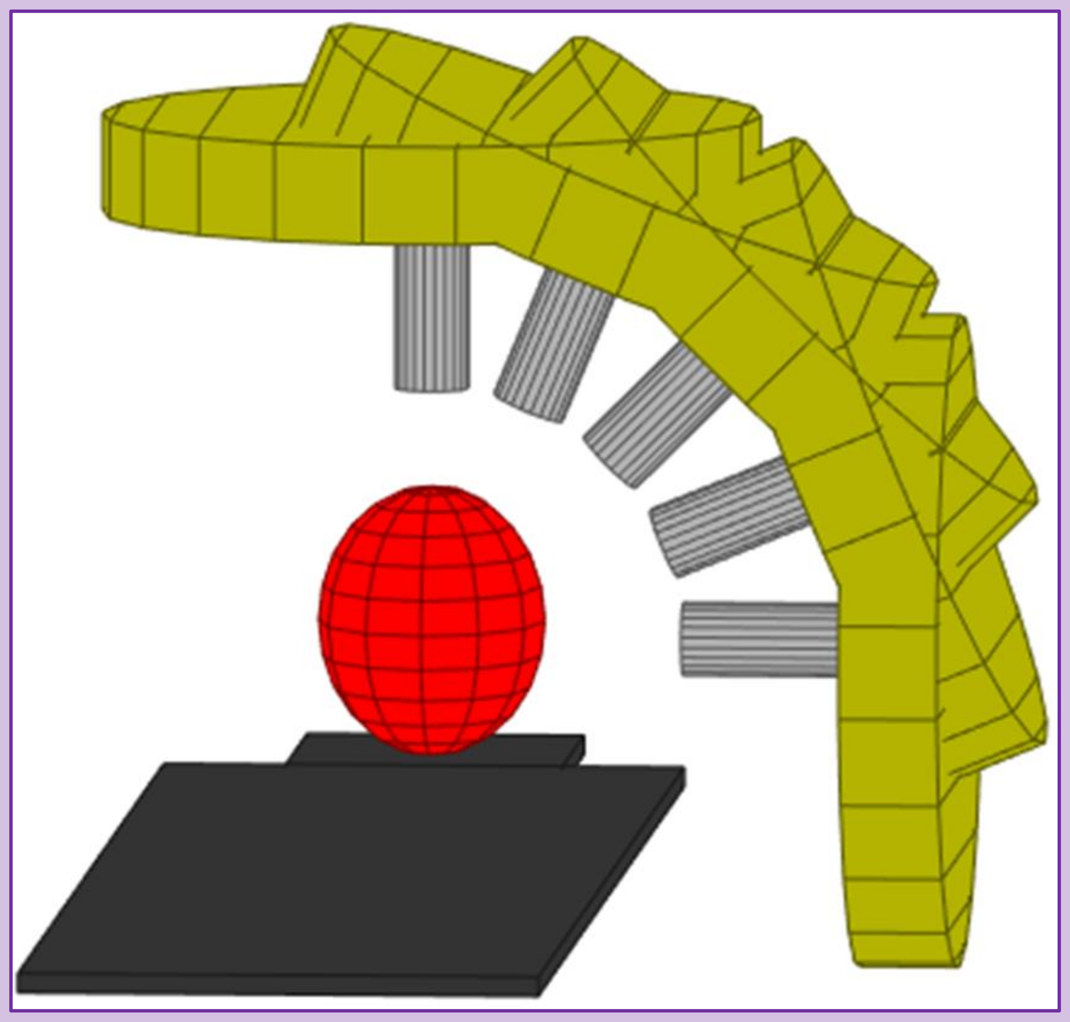

Figure 1. Example of program visualization for a patient located at isocenter, with no table rotation and a 90^{o} gantry rotation.

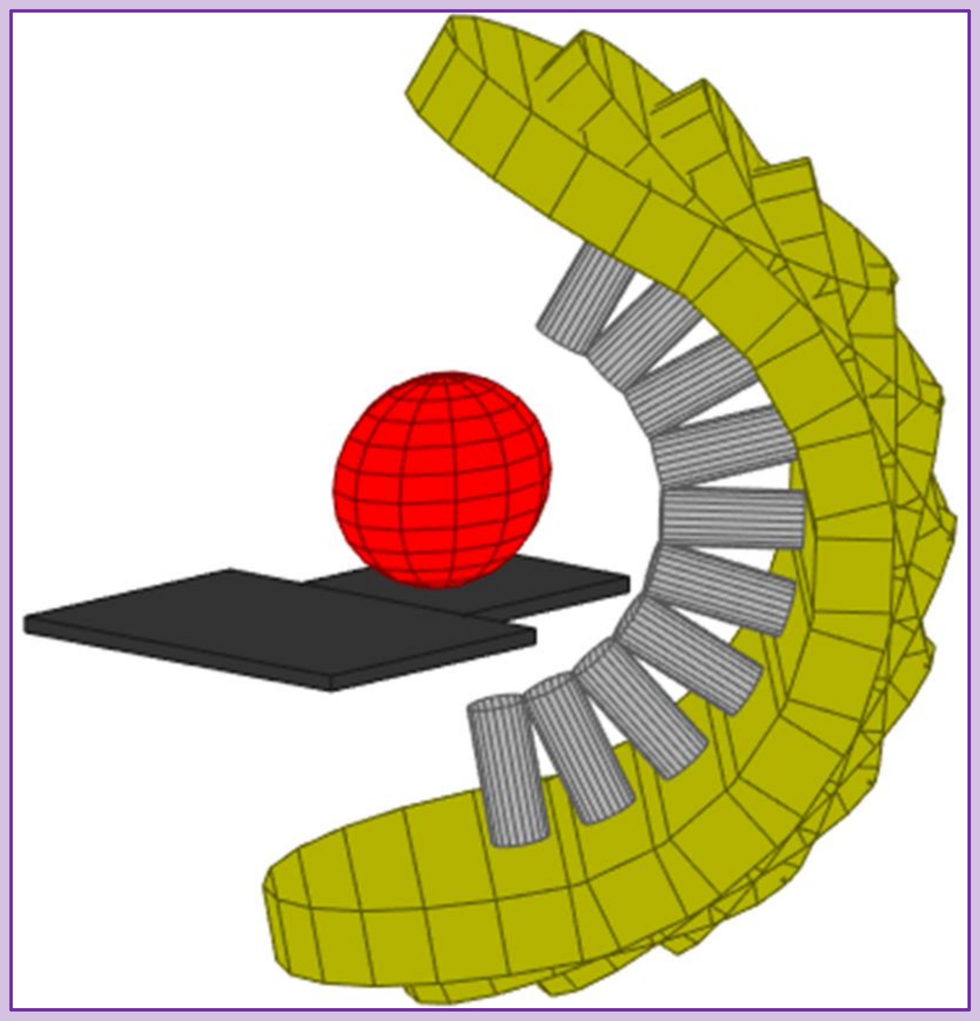

Figure 2. Example of program visualization for a near miss with a table rotation of 250^{o}, a shift away from isocenter and a 150^{o} gantry rotation.

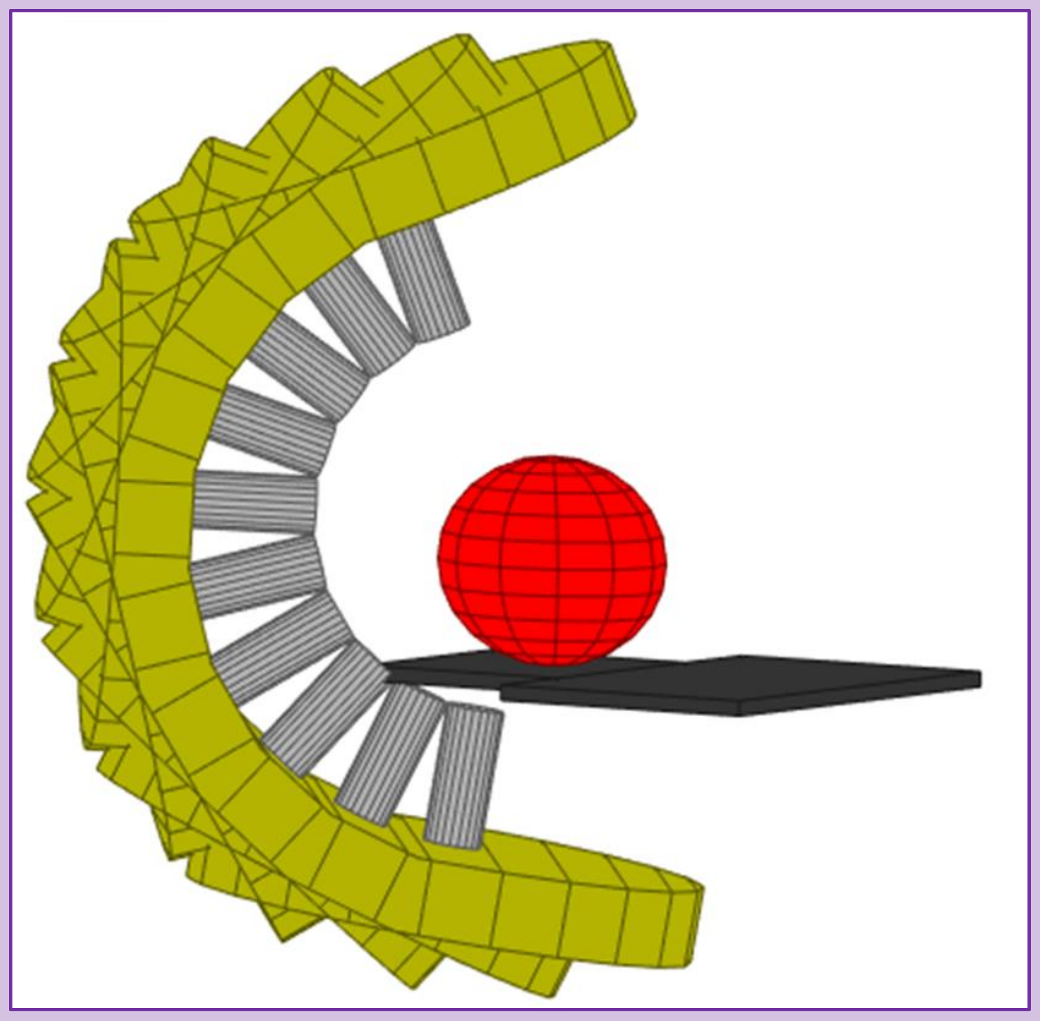

Figure 3. Example of program visualization for a collision in a right occipital tumor with a table rotation of 110^{o}, a shift away from isocenter and a 130^{o} gantry rotation.

Conclusion

This simple program can be used by the planner, physician or physicist to find the best orientation of beams for each patient. By finding collisions before a plan is being simulated in the treatment room, the clinic can save time due to replanning of cases. This collision code was tested and was found to be accurate in finding cone collisions while planning. Note, this software does not replace the need for in room collision assessment. It is only meant to reduce the number of cases that are found at that point.

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