

Purpose: Real-time tumor tracking for Tomotherapy systems is a problem in need of a solution. Currently, magnetic tracking systems, such as Calypso, are unable to localize a magnetic source due to the conducting bore. Eddy currents generated in response to the source create additional magnetic fields, at the source frequency, that are difficult to model and filter from the signal. Therefore, we are presenting an innovative method to solve this problem.

Method: We have developed a localization algorithm based on a transponder source within a conducting cylinder, and a cost effective sensor configuration. The algorithm uses magnetic field gradients, as well as the magnetic fields, to effectively filter magnetic fields generated from surrounding eddy currents induced along the gantry. Solution accuracy depends on the sensor geometry and configuration; and therefore, the method is a combination of algorithm and sensor parameters to maximize accuracy, while minimizing cost to create a practical system. We modeled the gantry and transponder system to simulate the magnetic fields throughout the environment. The sensor fields were used as algorithm input to calculate the transponder location. The location of the transponder was compared with the calculation.

Results: We investigated different algorithms, sensor geometry, and sensor configuration. We compared our method to traditional localization methods of Wilson, Nara, Chao, Hashi, and McGary. Those methods were unable to attain suitable clinical treatment accuracy due to the conducting bore. The method presented here was able to locate the transponder within 1-2 mm over a large extent of possible transponder positions and orientations. In certain regions, the localization error increased to about 3-4 mm due to the nearby eddy currents.

Conclusions: The method, algorithm and sensor design, is capable of locating a transponder, for real-time tumor tracking, in a modeled Tomotherapy gantry bore within 2-4 mm.

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