A Flexible Integration of Key Technologies in Image-Guided Radiotherapy for Accurate Radiotherapy System (ARTS-IGRT)

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Objective: Image-guided radiotherapy (IGRT) is becoming increasingly important in the planning and delivery of radiotherapy. With the aim of implementing the key technologies in a flexible and integrated way in IGRT for accurate radiotherapy system (ARTS), a prototype system named as ARTS-IGRT was designed and completed to apply main principles in image-guided radiotherapy.

Methods: The basic workflow of the ARTS-IGRT software was completed with five functional modules including management of patient information, X-ray image acquisition, 2D/2D anatomy match, 2D/3D match as well as marker-based match. For 2D/2D match, an image registration method was proposed based on maximization of mutual information with multi-resolution and regions of interest. For the 2D/3D registration, optimizations have been employed to improve the existing digitally reconstructed radiography generation algorithm based on ray-casting, and also an image registration method based on implanted markers with different numbers was adopted for 3D/3D match. In additional, the kV X-Ray imaging on rail device was finished for a better internal anatomy image checking at any angle. Together with an infrared device, a positioning and tracking system was developed as well for accurate patient setup and motion monitoring during each treatment.

Results: A lot of tests were carried out based on the head phantom to testify the availability of the improved algorithms. Compared with a set of controlled experiments adopted on the released commercial IGRT platform in the hospital, the functions of both software and hardware were testified comprehensively. The results showed a validity verification of ARTS-IGRT.

Conclusions: The accuracy and efficiency of ARTS-IGRT on both software and hardware proved to be valid. And also with a flexible and user-friendly interface it can meet the principles of clinical radiotherapy practice.

Keywords: Accurate radiation therapy, image guided radiotherapy, medical image registration