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On-line Setup Verification for Fractionated Stereotactic Radiotherapy (FSRT) using Digital Portal Imaging System : DRR, Simulation image vs. Portal image

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INTRODUCTION

Using Digital Portal Imaging System (BEAMVIEWPLUS, Siemens, USA), alignment is determined between the machine isocenter in performing Fractionated Stereotactic Radioth erapy (FSRT) and the target isocenter in treatment. For this purpose a combined system of hardware and software is developed to conform the reproducibility of patient's setup, a nd utilization of this system is evaluated.

METHOD

Both simulation image and portal image are acquired from a Digital Portal Imaging Sy stem and Digitally Reconstructed Radiography (DRR) image is obtained from a series of CT images. An interface is developed to make acquisition of DRR images possible in PC and a program of Remote Viewing Station is built to control DRR images in PC enviro nment. A mirror type Digital Portal Imaging System is used as a EPID for this procedure. For the test of alignment between the machine isocenter in performing FSRT and the tar get isocenter by means of analyzing DRR images, an analyzing software of Graphic User Interface (GUI) base is developed and the reproducibility of patient's setup is evaluated t hrough this software.

An isocenter is determined with the help of laser marker on patient body and orthogon al set of DRR images is computed and visualized from a series of CT images taken arou nd this isocenter. At simulator, an isocenter of simulation images is compared with that o f DRR images and the same procedure is performed in treatment. In treatment DRR ima ge may be substituted for the portal image to compare with the simulation image. Align ment of the isocenters may be established from the comparison of target contour, target c enter-of-gravity, image silhouettes and anatomical landmark, and this leads to the reproduc ibility of patient's setup in real time. By performing this procedure every treatment time,

errors of inter-treatment and intra-treatment can be analyzed with adjustment of translation (x, y shift), rotation and scaling. In case setup errors persists, isocenter verification may be repeated until this problem gets eliminated.

Registration Algorithm

Isocenters and anatomical features may be aligned by comparison of DRR images taken from simulation image and CT image. And then, DRR image can be fused with corresp onding tumor, critical organ, target center and con size, and compared with portal image obtained in treatment. Reproducibility of patient's setup may be verified by comparison of machine isocenter and target isocenter and also image silhouettes, anatomical landmark, t arget contour and target center-of-gravity. Least square method is introduced for this align ment of isocenters of portal image, simulation image and DRR image, and the same proc edure can be applied to anatomical region with the control of translation, rotation and sca ling for the goal of reproducibility of patient's setup. Our system is equipped with many useful functions such as automatic contouring, image processing and statistical analysis for visualization.

RESULTS

GUI-based analyzing software is developed to verify alignment of machine isocenter an d target isocenter, and reproducibility of patient's setup for the fractionated stereotactic rad iotherapy. Errors of isocenter misalignment is confined within 1 mm for translation, rotati on and scaling, and error of setup reproducibility is also within 1 mm. By analyzing erro rs of inter-treatment, and intra-treatment, we can show that data acquisition time is short enough and analization is performed objectively and quantitatively, leading to practical util ization of our software.

DISCUSSION

With adjustment of real distance per pixel, completion of GUI-based algorithm and pati ent database, and fusion of 3-D information of DRR image and good quality of simulatio n image, our software may be used as a clinical application for the purpose of quantitati ve display of alignment of isocenters and reproducibility of patient's setup. In general, qu ality of DRR image is not as good as that of simulation image but advantage of DRR i mage is that internal structure of image can be visualized more precisely.

CONCLUSION

Custom-made software is developed for the verification of alignment between machine i

socenter and target isocenter, and reproducibility of patient's setup in fractionated stereotac tic radiotherapy using Digital Portal Imaging System. As analyzing speed is fast enough a nd accurate, it may be used as a clinical application. In near future, utilization of our sof tware may be possible with completion of user interface and patient database.