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Development of a 4D Moving Phantom for the Verification of Delivery with Organ Motion

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Introduction

Patient internal organ motion has three dimensional motion components and shows complex motion characteristics. There is some need to recreate the internal organ motion for the quality assurance of motion compensated delivery and to verify the delivered dose distribution. In this work a 4D programmable moving phantom for the simulation of organ motion is presented and the performance is evaluated with respect to positioning accuracy.

Materials and Methods

A 3-axis robotic arm was fabricated and controlled by AC servo motors. (Fig.1) Dosimetric parts can be placed on the robot arm so that 4D rigid body motion can be recreated in the vector space. A PC-based motion program was developed to control the 3D position of the arm by processing position inputs from sinusoidal pattern or patient motion data. An external stereo camera monitored the phantom motion to verify the positioning accuracy with motion.

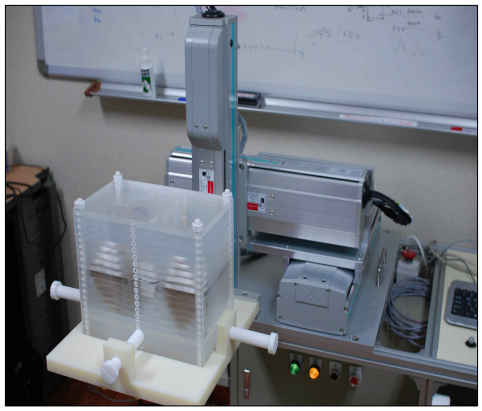

Fig. 1 An in-house moving phantom to simulate 4D organ motion

Results and Discussion

User-defined motion trajectory can be reproduced using the programmable 4D moving phantom within an accuracy of 0.5 mm, which was verified on the stereo camera system. Although a period for motion update is 10 ms, camera measurement showed that the resulting motion profile was smooth enough to simulate internal organ motion with the help of an interpolator in the motion controller. (Fig. 2)

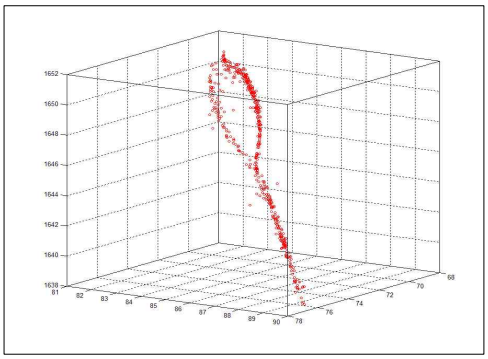

Fig. 2 3D plot of simulated motion trace for patient data in the developed program (unit: mm)

Conclusion

The 4D programmable moving phantom will be useful for the verification of 4D dose delivery and real-time target localization.

Reference

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