

AbstractID: 3080 Title: Design and applications of a 4D simulator for respiratory motion

Purpose: To design, construct, and evaluate a pneumatic respiratory-motion simulator for 4D radiotherapy. The device should be able to operate in dynamic mode for real-time simulation of patient breathing motion as well as snapshot mode for static dose measurement.

Methods and Materials: A simulator incorporating a cylindrical air reservoir with a piston was constructed as a tool in 4D radiotherapy studies. The piston movement is controlled by a programmable logic controller (PLC) which is interfaced to custom software written in Visual Basic (VB). The air reservoir is connected to a lung phantom made of two pulmonary simulation balloons. The pressure inside the lung phantom is monitored by a detector whose input is feedback to the PLC. The lung phantom is immersed in a water-filled box to simulate the normal tissue surrounding actual human lungs. The box is connected to a water reservoir to allow breathing of the lung phantom. A rubber ball is attached to the inner side of the phantom to simulate a lung tumor and gold seeds are implanted into it for seed-tracking studies. Spirometer-based patient respiratory waveform data in ASCII format were obtained from our department's breath-hold clinical study. The waveform data are input to the VB program and sent to the simulator for controlling the simulation.

Results: Preliminary evaluation of the simulator using several patient waveforms has been conducted. The respiratory motion of the lung phantom is found to be reproducible.

Conclusions: A prototype respiratory-motion simulator has been built which should prove valuable for 4D radiotherapy and related studies (gating, respiratory-induced organ deformation). Its unique design of using pneumatic means to simulate breathing motion allows more realistic simulation studies including those involving animal lung models.

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