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2443 Real Time 3D Surface Imaging for the Analysis of Respiratory Motion During Radiotherapy

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Purpose/Objective: With the introduction of advanced treatments such as CRT and IMRT, the effects of respiratory motion are now becoming increasingly significant during both the planning and delivery of radiotherapy. The purpose of this study is to record movements resulting from respiration using real-time 3D surface imaging to determine metrics with which the motion can be quantified, and to thus measure the extent to which breathing varies both according to anatomical site and from patient to patient.

Materials/Methods: AlignRT, a video based real-time 3D surface imaging system, was used to record 3D sequences of surface data of the torso region over 8-15 second periods at 3 frames/second. 3D surface data was acquired from 14 patients in the intended treatment position during CT simulation. In order to analyse the data, software tools were developed to extract transverse contours through the thorax, abdomen and pelvis, for all recorded frames for each patient. For each contour, 3 points were monitored (mid-line and 6-7.5cm Lt & Rt of mid-line). The Y coordinates (AP) of these points were measured. These values were plotted against time along both transverse and sagittal contours. Amplitudes, periods and phase shifts were compared across the contours and from patient to patient.

Results: Table 1 shows the results from the various patients imaged. Thoracic and abdominal contours were visible on seven patients, abdominal and pelvic contours were visible on five patients and all three contours were visible on two patients. On every patient the plots clearly showed respiratory motion. There was no measurable phase shift between the various contours monitored and the period of respiratory cycle for all patients ranged from 3s to 7s (mean 4.2s, SD 1.2s). With some of the pelvic contours, AlignRT was able to detect sub-millimetre movements of equivalent period and phase as significantly larger movements measured along abdominal and thoracic contours. With the exception of one instance where the thoracic contour moved more than the abdominal, the measured abdominal movements were larger than their thoracic counterparts. As expected, the amplitudes of the pelvic

movements were consistently smaller than those across the other contours.

Conclusions: The above results demonstrate that respiratory motion can be effectively monitored using real time 3D surface imaging and that there is significant variation in the extent of motion both according to anatomical location and from patient to patient.

Work is planned to repeat the study on a larger patient group and to record cycles for longer periods at a higher frame rate. More advanced metrics which look at the overall deformation of the surface as opposed to monitoring individual points along a single dimension are also being devised. In addition, further work is planned to register real-time internal image data acquired from MR and CT, to 3D surface data, in order to assess to extent of the correlation between the motion of internal organs and the external surface.

	Thorax	Abdomen	Pelvis
No of Contours	9	14	7
Maximum Amplitude (mm)	17.0	12.4	6.5
Mean Amplitude (mm)	3.8	6.1	2.3
Standard Deviation (mm)	3.3	3.3	1.8