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105 Real-Time 3D Surface Imaging for Patient Positioning in Radiotherapy

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Purpose/Objective: Accurate and rapid patient set-up is essential for the effective implementation of conformal and IMRT radiotherapy. A new system is presented that uses data acquired from 3D imaging of the external skin surface to improve the accuracy and reproducibility of patient setup, and to reduce the time required to achieve this.

Materials/Methods: A video-based imaging system has been developed by Vision RT Limited ("VRT") which generates high density 3D models of the skin surface without the use of markers. In the simulator room, a reference image is captured instantaneously of the patient in the intended treatment position. Prior to treatment, a surface model of the patient is acquired and is then matched automatically to the reference surface, hence providing couch adjustment information. The system operates in real-time and provides a colour-coded display to highlight discrepancies between the current and "reference" patient position.

The accuracy of the VRT system was determined using an Optotrak LED tracking system (RMS accuracy to 0.1mm) as a control. Ten LEDs were positioned around a phantom of the torso and the VRT and Optotrak systems were co-calibrated. The phantom was then moved to ten different positions. By registering the respective LED co-ordinates as tracked by the Optotrak and the 3D surface models as imaged by the VRT system at each position, a total of ninety combinations of motion were measured. In addition, speed tests were performed on the VRT system for both 3D imaging and surface matching.

Results: Selected co-ordinates within the imaging volume were transformed using motion information derived from both the Optotrak and VRT systems. The resulting co-ordinate error between the two systems was stored as the target registration error ("TRE"). This was repeated for all ninety combinations of motion for five randomly sampled points within a 300mm radius of the centroid of the working volume. Mean TRE errors were below 1mm and were 0.8mm at the centroid.

Speed tests were performed on the system when imaging both phantoms and human subjects. Surfaces were captured and processed at a frame rate of 2-3 frames/second. Automatic surface registration was subsequently performed on average in less than 2 seconds per match.

Conclusions: A new system has been demonstrated to provide accurate and detailed data for patient repositioning and automatic treatment couch adjustment. Phantom studies have proven high levels of accuracy, with sub-millimetre positioning errors. Furthermore, the frame-rate speed of the system enables practical patient positioning to be rapidly achieved with the potential of significant reduction in set-up time. Systems have been installed at St Thomas' and the Royal Marsden Hospitals where studies are underway to confirm both the accuracy and efficacy of the system within clinical practice by comparison with conventional lasers, CT and portal imaging. Additionally, further work is intended to utilise the real-time capabilities of the system for monitoring and respiratory gating.