Augmentation of optical surface using deformable registration for dosimetric assessment in breast radiotherapy

Tom Marchant[1], Gareth Price[1], Bogdan Matuszewski[2], Christopher Moore[1]

[1]North Western Medical Physics, The Christie NHS Foundation Trust, Manchester, UK

[2]ADSIP Research Centre, University of Central Lancashire, Preston, UK

The Christie NHS Foundation Trust

We Care, We Discover, We Teach

Purpose

Optical surface sensing is attracting increasing interest for verifying patient position during radiotherapy. However the optical data from just one sensor may not form a complete surface due to limited field of view (FOV) or areas of missing data caused by shadowing. This hinders re-calculation of delivered dose using the optical surface, which requires a complete surface contour throughout the region of interest. This work uses deformable registration to match patient contours from pre-treatment images to the optical surface acquired on-treatment. The deformed planning contours can then be used to extrapolate the optical surface into areas of missing data. We verify accuracy of the resulting extrapolation using CBCT data acquired simultaneously with optical imaging.

Methods

This preliminary study uses data from 2 breast IMRT patients. Optical surface data representing the mean patient surface was acquired using an in-house sensor based on Fourier profilometry [1]. Patient surface and lung contours were extracted from the pre-treatment planning images and these were deformably matched to the optical surface using a Spring Mass System algorithm [2]. The resulting deformed planning contour image was used to re-compute the dose. Accuracy of deformed planning contours and dose reconstruction was assessed by comparison to contours derived from an on-treatment CBCT scan acquired simultaneously with optical scanning.

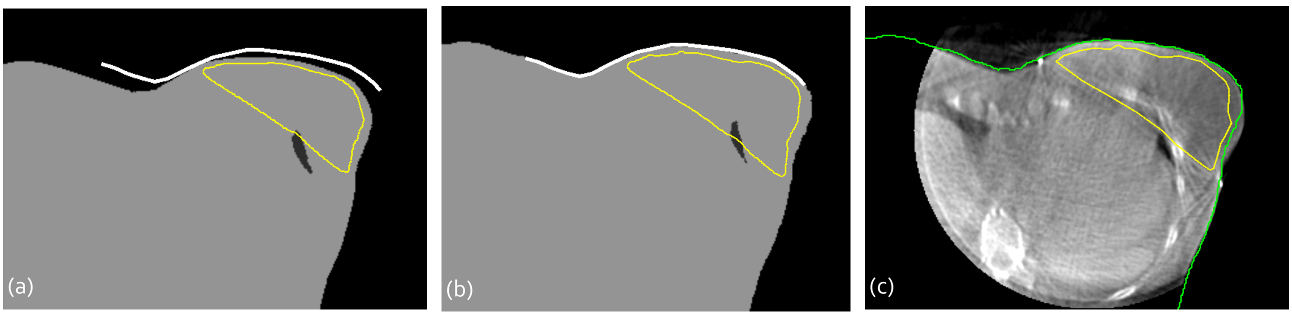
Results

Comparison to CBCT contours showed excellent agreement in surface position within the optical FOV and reasonable agreement in extrapolated areas (see figure 1). Dose calculations using the deformed planning contours agreed well with those based on CBCT contours. Mean breast dose agreed to within 9cGy for both patients (difference from planned mean dose of up to 70cGy was observed). The general distribution of dose hotspots showed reasonable agreement, although the position of the maximum dose hotspot was not exactly reproduced.

Conclusion

Deformable registration with planning contours shows promise as a method to augment optical surface data. Extension of this work to more patients is needed to further investigate differences from CBCT based assessment. Mean surfaces were used in this study to allow comparison to slow CBCT, although instantaneous surface data could be used to investigate intra-fraction motion. Deformation fields produced by the registration process could allow combination of dose distributions to show effects of intra or inter fraction motion.

Figure 1: (a) Original contours taken from planning CBCT scan with planned 95% isodose (yellow) and in-treatment optical surface (thick white line). (b) Deformed planning contours with reconstructed 95% isodose (yellow). (c) CBCT acquired simultaneously with optical surface showing 95% isodose based on CBCT (yellow) and deformed planning contours (green).



References

[1] Price GJ, et al., 2009, "An analysis of breast motion using high-frequency, dense surface points captured by an optical sensor during radiotherapy treatment delivery", Phys. Med. Biol. 54 6515.

[2] Shen JK, et al., 2008, "Deformable Image Registration - A Critical Evaluation: Demons, B-Spline FFD and Spring Mass System", 5th International Conference on Biomedical Visualization (Medivis '08), London, July 2008.

Acknowledgements

This work was supported by UK EPSRC grant EP/D078415/1
www.megurath.org