An Augmented Reality Tool to aid Radiotherapy Set Up implemented on a Tablet Device

Francesco Cosentino[†,1,2], Jaap Vaarkamp[1] and Nigel W. John[2]

[1]*BCUHB, North Wales Cancer Treatment Centre, Bodelwyddan, LL18 5UJ, UK.*

[2]*University of Chester, Department of Computer Science, Thornton Science Park, CH24NU, UK*

Introduction

The accurate daily set up of patients for radiotherapy treatment remains a challenge for which the development of new strategies and solutions continues to be an area of active research. We have developed an augmented reality tool to view the real world scene, i.e. the patient on a treatment couch, combined with computer graphics content, such as planning image data and any defined outlines of organ structures. We have built this on widely available hand held consumer tablet devices and describe here the implementation and initial experience.

We suggest that, in contrast to other augmented reality tools explored for radiotherapy[1], due to the wide availability and low cost of the hardware platform the application has further potential as a tool for patients to visualize their treatment and demonstrate to patients e.g. the importance of compliance with instructions around bladder filling and rectal suppositories.

Materials & Methods

To assist radiotherapy treatment set-up, we built an augmented reality application for widely available hand held consumer tablet devices using the Unity3D (Unity Technologies, 5.0) development platform and the Vuforia™ (PTC) AR library. The application runs on Apple iPads® and iPhones®, IOS 8.1, and above.

The device camera (iSight 5MP, f/2.4 aperture) continuously displays the real world scene at patient radiotherapy set up, including a marker that provides the reference point and real world coordinate system for virtual content that is generated at the treatment planning stage. The application reads surface information from outlines defined on a planning CT scan and contained in DICOM files generated by the Eclipse (Varian, 13.0) planning system. The magnification is adjusted with viewing distance and the application allows to toggle on and off computer graphics renderings of structures and adjust transparency, colour and illumination as required.

We have tested the application using an anthropomorphic phantom (RANDO, RSD Inc.) that was CT scanned on our Widebore scanner (Philips, Brilliance), using our clinical protocol for early prostate treatments (3 mm thickness, pitch 1). We performed a preliminary study of precision. The marker was positioned on the table to match the position of the CT outline with the physical phantom. This was repeated 30 times.

Results

Figure 1 shows the RANDO phantom body surface outline extracted from the CT scan overlaid to the image of the physical phantom on the developed application. The position of the phantom is adjusted manually to register the phantom view on the video stream with the

body outline. Slider controls allow the transparency, colour and brightness of the body outline to be adjusted, enabling the user to choose preferred visualization settings.

For the precision we found a standard deviation of 1cm and 3°.

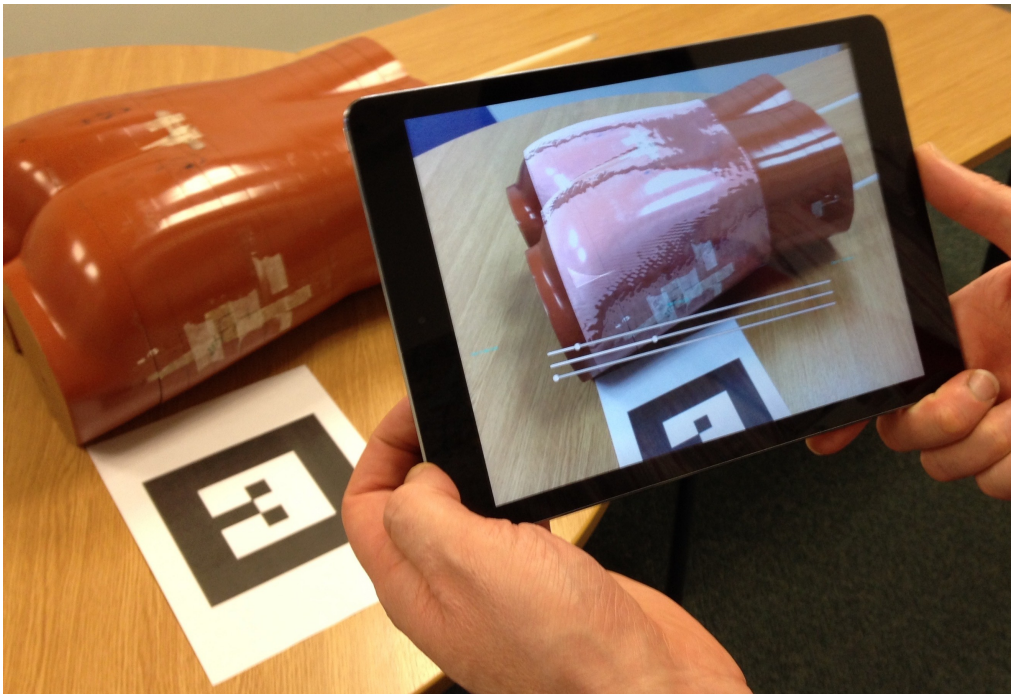

Figure 1: *The RANDO phantom and marker, and the tablet device with the application displaying the body outline extracted from a CT scan overlaid onto the RANDO phantom image*.

Discussion & Conclusions

The tool in its current implementation can aid to pick up large set up errors, such as those that can occur when applying incorrect couch moves or using incorrect, previous tattoos for set up. Further work is required to analyse the minimum errors that can be picked up and will be operator dependent. We also envisage further work to introduce the light field and a facility to look into the body to visualize how close a particular organ at risk is to the irradiated volume or treatment target.

At this point a role in adaptive radiotherapy could be envisaged and of course it would enhance the experience as a tool to explain to patients the radiotherapy process and the importance of complying with instructions around bladder filling and rectal suppositories.

References

[1] F. Cosentino, N. W. John and J. Vaarkamp (2014). An overview of augmented and virtual reality applications in radiotherapy and future developments enabled by modern tablet devices. Journal of Radiotherapy in Practice, 13, pp 350-364. doi:10.1017/S1460396913000277.

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†Corresponding Author: francesco_cosentino@hotmail.com