VIRTUAL REALITY FOR SIMULATION OF RADIATION THERAPY

Bannister H[1], Selwyn Smith B[1], Anslow C[1], Robinson B[2], Leong A[3], Kane P[3] & Coleman K[3,4]

[1] School of Engineering and Computer Science, [2]Graduate School of Nursing, Midwifery & Health, Victoria University of Wellington, Wellington,

[3] Department of Radiation Therapy, University of Otago, Wellington, [4] Radiology Department, Hutt Valley District Health Board, Lower Hutt

Introduction/Background

Cancer is responsible for around 10 million deaths a year, about one sixth of all deaths globally and forty percent of people will have cancer at some stage of their life. Radiation therapy is a common treatment, in high demand and requires highly trained radiation therapists. However, *in-situ* training of radiation therapy students (Figure 1) is impacted by the increasing demand for radiation therapy along with efficiencies aimed at increasing treatment numbers. Virtual reality radiation therapy simulation was developed over a decade ago[1] and is now commonly used in radiation therapy teaching programmes in response to increasing demand for training radiation therapists and the limited access to clinical equipment.

Figure 1. *In-situ* training of radiation therapy students

Education and Safety

Treatment errors are recognised to occur during radiation therapy and include incorrect dose and site of irradiation and patient harm has been associated with gaps in education and training[2-5]. The Department of Radiation Therapy, University of Otago Wellington, uses the Virtual Environment for Radiotherapy Training[6] (VERT) to provide immersive education across a three-year undergraduate programme. This is a fixed wall projection system generating images that can be viewed by a class in two-dimensional mode or by one student in three-dimensional mode. This provides several important contributions to conceptual learning for radiation therapy students[7] and supports informing patients prior to undergoing radiation therapy[8]. There are, however, limitations to this system that restrict introducing students to basic clinical motor skills for the alignment of patients, working in pairs, medical physics, treatment planning concepts and anatomical instruction[9].

Aim and Objectives

The aim is to develop and evaluate the usability of a head mounted portable immersive virtual reality (IVR) environment to facilitate teaching to radiation therapy students. The objectives are to develop IVR simulation that addresses the identified limitations of VERT and to explore the development of the virtual radiation therapy environment as a patient experience prior to receiving radiation therapy.

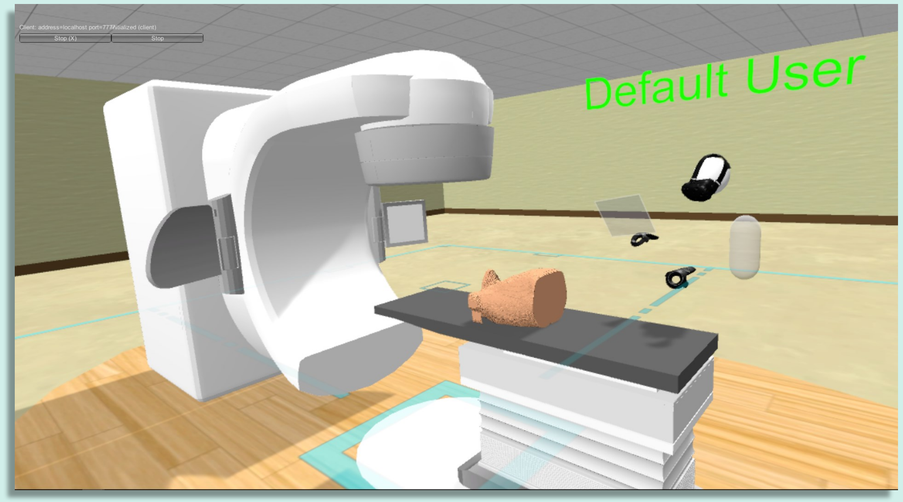

Figure 2. Linear accelerator (LINAC) immersive virtual reality environment

Methods

A linear accelerator (LINAC) IVR environment was created (Figure 2) that is viewed through head mounted devices and used as a proof of concept. This explored the use of multiple student user views and the patient view (Figures 3 & 4), all in three dimensional IVR. This system also allowed an additional instructor view in two dimensions. Radiation therapy educators and students were invited to use this system and provide their feedback on their experience and the usability of the system.

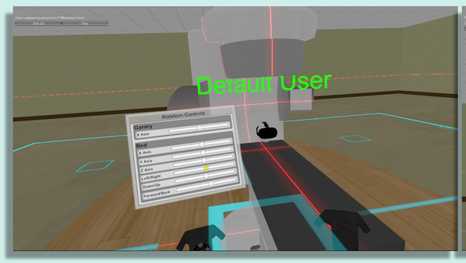

Figure 3. Multiple student user view

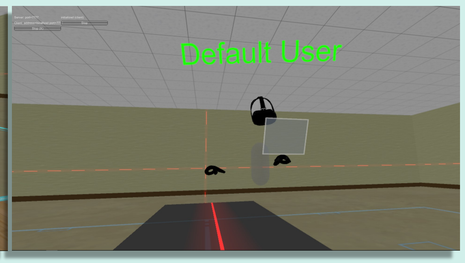

Figure 4. Patient view

References

[1]Bridge, P., Appleyard, R.M., Ward, J.W., Philips, R. and Beavis, A.W., 2007. The development and evaluation of a virtual radiotherapy treatment machine using an immersive visualisation environment. *Computers & Education*, *49*(2), pp.481-494.

[2]Carlson, A. L. *Medical errors in radiation therapy.* Bureau of Radiation Control, Florida Department of Health, http://hpschapters.org/florida/PPPT2.pdf. Accessed: 09-08-2018.

[3]Kaczur, R. Safety is not an accident: Lessons to be learned from catastrophic events. The American Association of Physicists in Medicine, http://chapter.aapm.org/pennohio/2013FallSympPresentations/FI2_Ray_Kaczur.pdf. Accessed: 09-08-2018.

[4]Terezakis, S.A., Pronovost, P., Harris, K., DeWeese, T. and Ford, E., 2011. Safety strategies in an academic radiation oncology department and recommendations for action. *The Joint Commission Journal on Quality and Patient Safety*, 37(7), pp.291-299.

[5]Knöös, T., 2017. Lessons learnt from past incidents and accidents in radiation oncology. *Clinical Oncology*, 29(9), pp.557-561.

[6]Vertual Ltd. http://www.vertual.co.uk/. Accessed: 09-08-2018.

[7]Montgomerie, D., Kane, J.P., Leong, A. and Mudie, B., 2016. Enhancing conceptual knowledge: an approach to using Virtual Environment for Radiotherapy Training in the classroom. *Journal of Radiotherapy in Practice*, *15*(2), pp.203-206.

[8]Flockton, A., 2017. Men's experience of virtual simulation to aid patient education for radiation treatment to the prostate. *Journal of Medical Imaging and Radiation Sciences*, *48*(1), pp.S6-S7.

[9]Kane, P., 2018. Simulation-based education: A narrative review of the use of VERT in radiation therapy education. *Journal of Medical Radiation Sciences*.

Results: Four radiation therapy educators and 11 radiation therapy students took part in the user evaluation. The results of the Likert scale questions are shown in Figure 5.

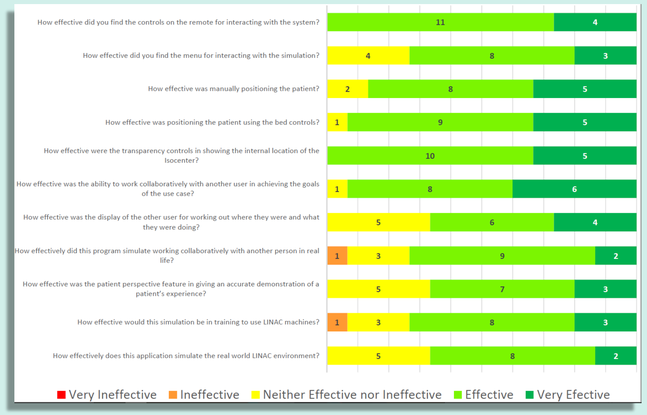

Figure 5. User evaluation responses

Written feedback identified suggestions for enhancing fidelity between the simulated and clinical LINAC environment::

"Slower Gantry, Hand controls different to LINAC pendants"

"Sound the machine makes as it delivers RT"

"Markings on skin."

Compared to the current VERT system, respondents described these aspects of the IVR environment:

"A lot more user friendly than my experience with VERT, would be beneficial for patient education to give an idea of what a LINAC actually looks like"

"Similar to VERT but this gives us the freedom to move around and we feel like we are in the clinic even when we are not."

"...more useful than VERT in preparing students for the clinical environment. ....more interactive and cool that ... two users to work together at the same time"

Participants provided suggestions for additions, changes and improvement:

"Put in the sounds the LINACs make"

"Whole body Dataset for realism."

"Maybe a body on the person using the VR simulation"

Other comments relating to applications:

"Really enjoyed the experience, …….. beneficial for both staff and patients."

"Transparency controls were useful in showing GTU, isocenter etc."

"….. helpful for patient education & easing anxiety of patients. …….. value in its use for educating complete beginners, or introducing new techniques for staff."

Discussion

There are significant variations how VERT is used by academic centres or may support comprehensive education and training that is aligned to an existing curriculum[9]. Head mounted IVR simulation provides an opportunity to support radiation therapy educators, students and clinicians with new technology alongside existing technology. The technology can be modified and adapted to become more clinically realistic and assessed for acceptability by patients to experience the IVR LINAC environment.