ITEC 2019 – Tackling Recurrent Training for Deployed Crew Using Portable Virtual Reality

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Abstract — Focussing on how to maintain the student's currency without taking them from an active deployment to undergo training, this paper outlines the challenges faced in designing a low cost, immersive, portable FDO training solution for deployed crew using Virtual Reality (VR).

1 Introduction

This paper explores the journey from a large scale; fully integrated classroom based training system to a 'portable' solution that qualifies as hand luggage on major airlines.

The paper explains the design, research, and experimentation activity that supported the development of a portable VR training solution. The paper identifies challenges discovered and how they were resolved including; training effectiveness, high expectations from students for the latest high-fidelity graphics versus available training budgets and overall how the solution will support recurrent training for deployed FDO's with no loss in training standard compared to the class room based system.

2 Background

Fully interactive, classroom based training systems lend themselves to being larger, heavier and in most cases a permanent installation, they are however limited to being at a single location and with limited availability.

If the same capability could be transformed into a portable system, it would have added benefits to deployable training, allowing training to be delivered at such locations as; the back of a vehicle, in a ship's hangar bay or an unutilised classroom space.

As training budgets continue to be reduced, end users are continually looking for innovative training solutions to reduce cost, improve safety awareness and increase efficiency of training delivery. As a result synthetic training solutions that use VR are becoming normal practice.

3 Portability

The main aim was to take existing training requirements of a classroom based training system and make it fit in a single case that would be accepted as hand luggage on all major airlines, becoming 'portable'.

With advances in VR this is made possible using a VR Headset, a mid-range laptop and an extra display.

4 Performance

Due to the portability requirement, using a VR headset and with an additional training screen requires high performing hardware and optimised software.

4.1 Hardware

The two systems were compared and the classroom based training system comprises of the following:

- 4 x large tower gaming computers
- 6-8 x desktop monitor screens
- 2 x large ceiling mounted projectors
- 1 x gesture recognition device
- 1 x audio system
- 1 x communications system
- 1 x push-to-talk system

Fig. 1. Fixed classroom installation

So in order to meet the performance demands a portable system with the following specification was selected:

- 1 x 17" Laptop with NVIDIA Quadro P4000
- 1 x Universal Serial Bus (USB) portable screen
- 1 x Oculus VR HMD + VR Controllers
- 1 x Microsoft Kinect Sensor
- 1 x Xbox 360 Gaming Controller

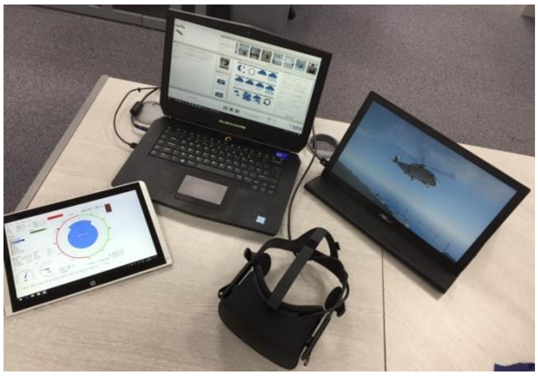

Fig. 2. Small footprint, easy to use and highly portable equipment selection

4.2 Performance Analysis

In order to achieve the same reliability of the classroom based training system, the laptop with the fastest gaming GPU had to be traded in favour of reliability. This meant extra challenges to provide the same number of 3D visual displays that the fixed system provides; a student VR 3D view and a 3D view for the instructor.

Table 1 shows the deltas of the pixels per seconds required for a single computer on the fixed system and the proposed portable system.

Table. 1. Current metrics vs target metrics for scene

	Number Of Views	Number of Pixels rendered	Frame rate (Hz)	Total Pixels per second
Fixed System	1	2,073,600	50	103,680,000
Portable System	3	4,665,600	90	419,904,000
Delta	2 (300%)	2,592,000 (225%)	40 (180%)	316,224,000 (405%)

Table 1 gives a rough idea of performance requirements, but clearly highlights the performance deficit.

4.3 Optimisation

Modern CPUs and GPUs are extremely powerful, the challenge is full utilisation. The following section provides extra detail to this challenge.

The simulation engine we use comprises of a number of libraries; by upgrading these libraries it was possible to gain a significant performance boost, but it still fell short of the target frame rate of 90 frames per second (FPS). As a result more detailed analysis was required which led to further optimisation techniques.

In order to reduce motion sickness whilst using a VR headset, rendering latency needs to be minimised. The Software Development Kits (SDK) for the VR HMD have specific techniques to ensure this is minimised, but these techniques can cause further performance loss if they are not understood and used correctly.

5 Emulated Equipment

One of the major training requirements of the classroom based training system is the student's interaction with physical or emulated equipment. The vast majority of emulated equipment used in the classroom trainer is provided by a series of touch screens, displaying equipment graphics that can be interacted with.

Providing a touchscreen setup in a portable system is not portable and would decreases the training effectiveness as the student would need to remove the VR headset to interact with it.

Following some research for placing emulated equipment inside a virtualised environment, the two areas of focus needed to be; how to display/render the equipment? , how to interact with the equipment?

5.1 Rendering Emulated Equipment

To address the emulated equipment issues the first task was to model the target equipment in 3D and render it in the virtual environment. This produced convincing models within the VR HMD, however extra work would be required for modelling dynamic instrumentation panels. This led to research exploring the possibilities reusing and displaying 3rd party emulation software inside a 3D simulation engine.

5.2 Emulated Equipment Interaction

VR controllers, bundled with VR HMDs, provide an accurate method of tracking the hand position relative to the users head. Other devices are available with a much higher degree of accuracy that can track hands and fingers without a need to hold a VR controller. The type of device used is predominantly down to the type of training required.

6 Graphics Quality

An unexpected outcome during development was the extra work required to get the same or better graphics quality when viewing through a VR HMD when compared to the quality of the classroom systems graphics. This was due to three topic areas; higher quality display technologies; stereoscopic rendering (depth perception) and the ability to move around and look at any part of the virtual world.

8 Author Biographies

Ben Webb; a Project Manager, specialising in delivering; high fidelity, low cost, innovative training systems with over 10 years' experience to military and civilian customers, Ben has delivered projects internationally across the globe. Ben and his teams have delivered innovative training solutions with a focus on added user benefit, including; Gesture Recognition to relieve instructor training burden, Augmented Reality for Situational Awareness and portable Virtual Reality training to tackle recurrent training for deployed crew members.

Angus Laurie-Pile; a software engineer who is also Chartered Engineer with The Institution of Engineering and Technology with a Master's in Engineering in Computer Science. Angus has been designing software solutions for over 14 years with experience including; signal processing, control systems and simulation systems. As a result, Angus is the software lead for the External Communications control software for UK submarines and the technical lead for the simulation and training portfolio at Systems Engineering & Assessment Ltd.