Prototyping Large Scale Projection Based Experiences in VR

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ABSTRACT

The aim of this research was to develop a technique to simulate large scale, location-based installations in VR. The project is a collaboration with Aardman Animations, a world-renowned animation studio developing a projection-based installation. We developed a room-scale VR experience to simulate the installation in order to visualise the projection distortion under different conditions. A study was then conducted using our simulation to investigate the effect of distortion of the projections on the experience of immersion and how three factors effected the distortion.

Index Terms: Hardware [Simulation and emulation]: ;— [Human-centered computing]: Virtual reality—; Computing Methodologies [Virtual Reality]: —

1 INTRODUCTION

Virtual Reality is used across many industries to simulate real-world design propositions in order to explore the implications of different designs such as manufacturing, engineering, and architecture [1]. Taking advantage of the benefits of VR to create full scale simulations quickly, with less expense which can be changed and easily adapted. These environments can be used as a testing ground for design choices to avoid costly mistakes and improve the design process [2].

The immersive storytelling industry is a fast growing industry, with many storytellers and narrative companies such as Disney adapting well known stories and characters to immersive experiences. Audiences are also keen to share these experiences with friends and family with the location-based entertainment market growing increasingly. However, new installations are hugely expensive to build and using innovative new technological set ups means there can be questions on how immersive the experience will be and what effect the design will have on the audience. There is a need from within mixed reality research for more exploration into immersive design methods and practices, that can be shared within the community and are based in data [3]. Virtual Reality can provide a transformative design tool to test and iterate on designs. In this paper we explore a case study of using VR to simulate large scale immersive installations to investigate the effect of distortion on immersion and how different set ups can alter this experience.

2 BACKGROUND

Aardman Animation are a world leading animation studio, with well known character such as Shaun the Sheep and Wallace and Gromit. In this project we worked together to design an experience taking the linear narrative of Shaun the Sheep into a location-based, real-time, interactive, and spatially immersive experience that would debue in China. As part of the research project a installation design was developed that would allow users to interact with characters and each other in a shared space, without the need to put on any equipment. The design was a 15 x 15m square space with projections on the four walls and the floor. The audience would enter the space and a narrative would play on the screen which they could interact with through movement, sound and props. The problem was identified that the projections set up in this way with synchronous content would produce distortion where the walls and floor. This project sought to understand how much this distortion would affect immersion and what conditions affect the distortion. These questions needed to be answered before the full design of the space and animations were developed. We therefore created a virtual environment to simulate a short scene from the storyboard. We chose a scene which involved movement of the audience through the virtual environment as this would be an example of the most extreme case of distortion. The scene starts in a barn with a platform in the middle, the audience are encouraged to stand together on the platform, it then descends to the bottom of the barn. As it reaches the floor the barn collapses around revealing a countryside environment.

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3 EXPERIMENT DESIGN

3.1 VR Experience Set Up

Two VR projects were developed in Unity 3D for the Vive Pro 2. This set up was chosen as it enabled the highest quality of video to be used for the projection videos. Project A the main experiment models the installation projection screens and project B to create the animation for projections. Project A had five planes, four to simulate the walls of the installation and one on the ground for the floor projection. The planes were scaled to create a 15m x 15m box, matching the proposed installation space. Each wall could play synchronous videos. Project B had a model of a barn with a platform in the middle, the scene set up to play an animation of the platform descending. There were 5 cameras to record the projection for each plane in the barn simulation. The videos were recorded matching the resolution of the headset to reduce aliasing 4896 x 2448.

3.2 Scenario Design

The experiment was designed to test three factors and how they influenced the distortion on immersion. The first factor was position in the barn P1 at the center of the platform, P2 at the corner of the virtual platform and P3 the corner of the installation. The second was barn size, the first was 30 x 30 (large) two times the size of the installation walls, 20 x 20m (medium) and 15 x 15 (small) matching the size of the installation. The third factor was whether objects were present inside the barn, one condition without objects and one with objects placed in the corners of the barn walls Fig. 1. Each condition would feature a different combination of these factors creating 18 scenarios. Each scenario started facing the same direction of the barn door but participants could look around freely whilst the scenario played. At the end of each scenario participants were asked “On a scale of 1 to 10 how much did distortion effect your experience of immersion”. 1 meaning that distortion did not affect the experience at all and 10 meaning the distortion ruined the experience of immersion. Participants were explained what distortion meant in this context at the beginning of the experiment.

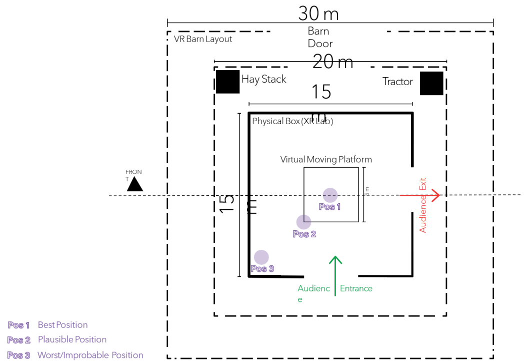

Figure 1: A image showing the floor plan of the immersive experience.

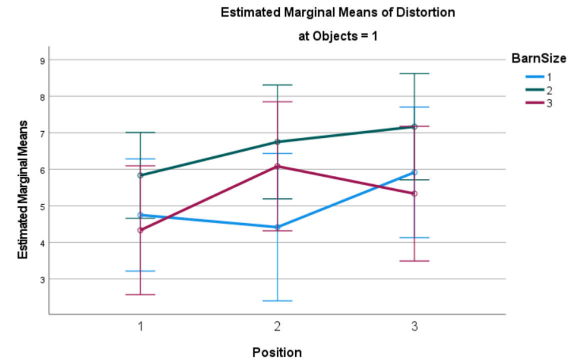

Figure 2: Estimated Marginal Means of Distortion with no objects

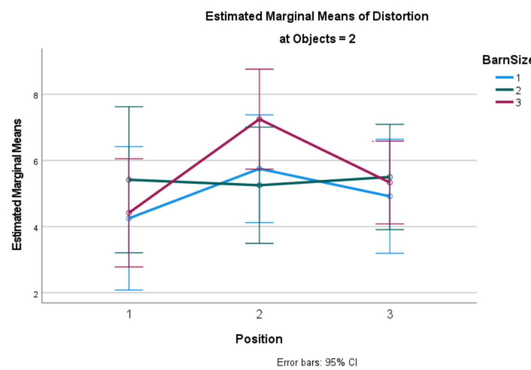

Figure 3: Estimated Marginal Means of Distortion with objects.

4 Participants and Procedure

A total of 12 participants attended our preliminary study. They were all students from Goldsmiths University. Participants were briefed on what would happen in the first 18 scenarios and told what question they would be asked. They were explained what was meant by distortion and given the chance to ask questions to develop an understand of the context. The 18 scenarios were played in a randomized order with the question asked between each experiment. Participant head movement data was recorded throughout each scenario to track where they moved. The screens which the headset was oriented towards were also recorded and the exact position of the hit point of the gaze.

5 Preliminary Results

We conducted a Three-way Repeated Measure ANOVA with the three factors being Position (P1:middle, P2: platform edge, P3: room edge), Barn size (S1: 30×30; S2 20×20; S3: 15×15), and Object (O1: with objects; O2: without Objects). The only statistically significant result was Position ($F(2,22) = 5.51, p = .011, \eta^2 = 0.334$). Position was expected to be a significant factor in the effect of distortion, however, how this was reflected in the results was unexpected. In the condition with no objects, in the middle sized barn (barn size 2) the position results are to be expected with position 1 at the centre with the least distortion and distortion increasing as you move away from the centre see Fig. 2. In barn size 3 (small) position 2 at the corner of the platform has slightly less distortion effect than position 1 with position 3 with the biggest distortion effect. Conversely with barn size 1 (small) position 2 has the biggest distortion effect, followed by 3 and one being the least. In the condition with objects the result are quite different Fig. 3. In barn size 2 there is very little difference between the three means with all three positions having a similar distortion effect. In barn size 1 (large) and 3 (small) there is a similar trend in position 1 the least distortion effect is experienced and the largest effect experienced in position 2. In barn size 3 (small) the difference between 1, 3 and 2 is quite large with a significant spike in the graph. These are very interesting results and more analysis of the data will be done to further explore the data.

6 Conclusion and Future Work

We created a VR experience to simulate a large-scale projection-based installation in VR. We found that VR was a useful tool in creating a model of an installation where design choices could be played out. We investigated how it could be used to measure how much distortion effected the experience of immersion and which design scenarios affected the intensity of this effect. We found that position was the only significant factor in the effect of distortion on immersion, however, this did not play out in the expected way across the different factors. More analysis of the data is needed to explore exactly how these factors interacted with each other. This is very significant in how the experience will be designed as development continues. Future work will be done expanding the participant size and carrying out tests with our partners in China. We have also been working with machine learning and body-tracking to design movement interaction for large-scale group interactions. Utilising the high rendering capabilities of Unreal we will use machine learning tool InteractML to design the interaction. We have been using the Zed 2i AI camera which has a wide angle lens suitable for large areas, multiple person body-tracking and object detection for use with props.

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