Innovations in Computing Technology and Applications
Volume 2 | Year: 2017 | ISBN: 978-967-0194-95-0

Audio-Induced Interaction Virtual Reality Game

Izwan Harris Ismail Jafli[1] and Norhaida Mohd Suaib[2]

[1]Faculty of Computing, Universiti Teknologi Malaysia (UTM),
81310, Johor Bharu, Johor, Malaysia
{izwanharris@gmail.com[1],haida@utm.my[2]}

Abstract. Immersion into Virtual Reality (VR) is a perception of being physically present in a non-physical world. The perception is created by surrounding the user of the VR environment in images, sound or other stimuli that provide an engrossing total environment. In order to optimize the immersive feeling of the simulations, the remaining issue is to balance the trade-off between realism and interaction methods while still adhering to cost and hardware constraints. Enhancing the feeling of realism when the player enters the world of VR is the main objective of this project. Therefore, this project aims to add a new main interaction cue to a VR game, that is interaction induced by sound-cues. The game uses spatial sound as interaction cue rather than depending entirely on visual cues. In order to actualize the aim, several phases needed to be carried out. Firstly, a VR headset has to be selected, followed by setting up the appropriate VR technology in the development environment. The game is designed to work with VR immersion technology and the interaction be enhanced by spatial sound. Game mechanics such as shooting, randomizer and enemy behaviour are then implemented to complete the game. Subsequently, the integration of an audio engine to spatialize the sound is required. Finally, the evaluation phase is conducted. Based on the result, the immersive VR game has been enhanced by implementing the spatial sound as an interaction cue.

Keywords: audio-induced virtual reality (VR), game, immersive, sound-cues, realism.

1 Introduction

The project aim is to develop an audio-induced interaction virtual reality game. The word virtual, in the computing world means an entity that does not physically exist but is made by software to appear as if it really exists. Virtual Reality, or VR for short is an alternate world that is created by special software and is viewable through specially-designed hardware. Virtual Reality (VR) devices range from high-end expensive devices which simulate depth as well as motion-tracking, to cheaper affordable ones which does not support motion tracking, and use cheap material but creates an immersive environment nonetheless. VR also simulates the user's physical presence in the virtual world and allows the user to interact with the world. A quick and common example would be video games, which are set in a computer-simulated reality that can be either an imaginary world or a real-life adaptation of a certain place on Earth.

The transformation of experience via acoustic storage and simulation of spatial audio is not only much easier to accomplish, but is also usually more convincing compared to the synthesis of virtual visual experiences. Intuitively it seems that audio is simply easier to use for transportation into a virtual world [1].

2 Related Work

2.1 Head-Mounted Display

Sutherland (1968) states that the fundamental idea behind the three-dimensional display is to present the user with a perspective image which changes as the user moves. This perspective image, will change only as the user's head moves, by measuring the position and orientation of an optical system that is fitted on the user's head. In the early builds, two cathode-ray tubes are fitted in the headset to present a virtual image to the user [2]. The headset that Sutherland depicts in his project is shown in Figure 1.

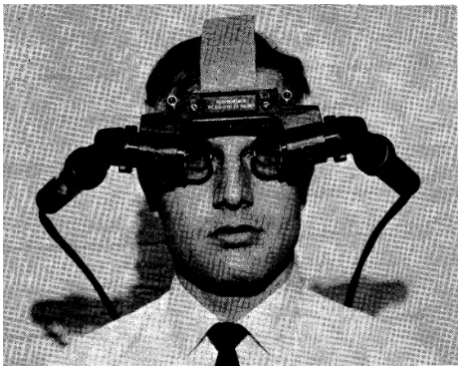

Figure 1. Early Head-Mounted Display Build [2]

2.2 Virtual Reality Technology

Technology in VR field has evolved at an exciting pace. Increasing number of companies have invested into VR technology and have come up with modern ways to enjoy VR. Some of the notable technologies is studied and presented.

HTC's Vive is a VR headset that is designed specifically for VR. The HTC Vive, is backed by Valve, a widely known big company in the gaming industry. The unique feature that comes with the Vive is that it houses a 720p camera on the front, for object tracking and pass-through, which would allow you to see the room outside your headset without removing the headset. The Vive, as seen in Figure 2.10, is also targeted to be used in a room, while standing or walking, also known as room-scale VR [3].

Figure 2. HTC Vive [3]

2.3 Theory of 3D Sound

3D sound, also known as spatial sound, is relatively rare compared to stereoscopic display that are rapidly becoming common technology. Stereo and surround sound speakers are usually the norm in most households.

Both surround sound and stereo sound are not able to cue a source's precise location in 3D space. Both technologies have limits in the positioning of sources to a single horizontal plane. 3D sounds however, targets sound source creation at any or all required locations in a continuous 3D space. This, in turn would create a new level of realism and opens the door to a new field of action-tasks and cues available to content designers. The major difference between 3D stereoscopic visual displays and regular 2D displays is enhanced depth perception [4].

3 Project Methodology

Figure 3 illustrates the project methodology. The initial stage is largely a study conducted on virtual reality (VR) technology.

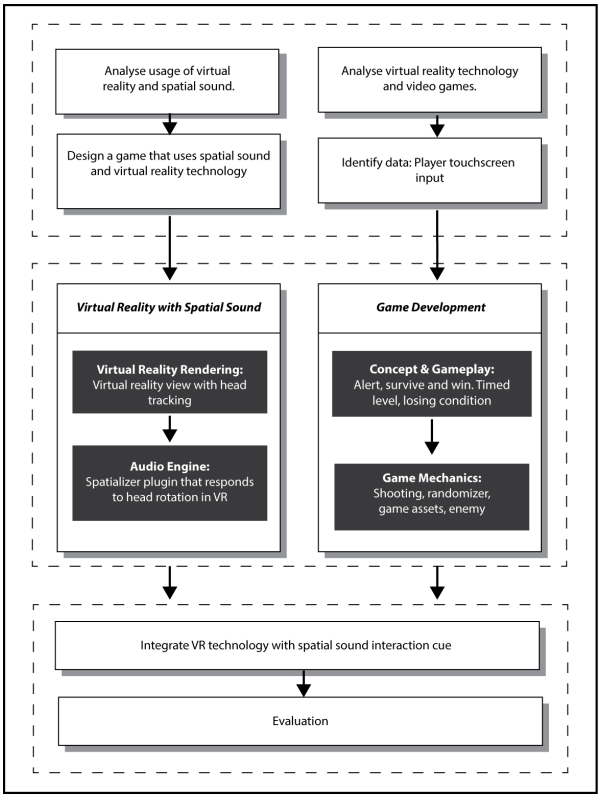

Figure 3. Project Methodology

Aspects such as the display technology, interaction, implementation and application was analysed to assist in the understanding of the technology before coming up with a suitable game design revolving around VR. Some study has been done on human hearing, theory of 3D sound and the audio spatializer technology to ensure the audio engine chosen would be implemented well.

Phase 1: Study of Virtual Reality (VR) and Spatial Sound

The initial stage is largely a study conducted on virtual reality (VR) technology. Aspects such as the display technology, interaction, implementation and application was analysed to assist in the understanding of the technology before coming up with a suitable game design revolving around VR. Some study has been done on human hearing, theory of 3D sound and the audio spatializer technology to ensure the audio engine chosen would be implemented well.

Phase 2: Designing the Game Structure

In this stage of the development, the rough design of the specific prototype iteration is sketched and made visible before the actual implementation takes place. Some designs also evolve parallel with the development, as deemed fit.

Phase 3: Developing the Game Mechanics

The basic user-interface (UI) is set up so that it is easier to test the game. The next progression includes the attachment of sound files to the enemy spawn locations, allowing

the sound source to play before the enemy is instantiated. Randomizer scripts are coded for both interval spawn and location spawn, to prepare the enemy.

Phase 4: Implementing Virtual Reality and Spatial Sound

Unity 5.6 has native support for VR development. Therefore, with some tweaking in the player settings, the VR rendering supports real-time head tracking within the game.

Phase 5: Evaluation

The evaluation phase takes into account the VR technology and the integration of audio-induced interaction in the game. The results of this project obtained through usability testing (Dumas & Redish, 1999) and black box testing (Jangra et al., 2011). The results are evaluated further in Chapter 5.

4 Implementation

4.1 Implementing VR Rendering

As this project is aimed to be a VR game, it is essential to be able to render the game in VR. In Unity 5.6, virtual reality rendering is natively supported. As shown in Figure 4.1, the 'Virtual Reality Supported' checkbox opens up a list of options that is supported natively in Unity 5.6. Cardboard is chosen here as that is the target deployment platform.

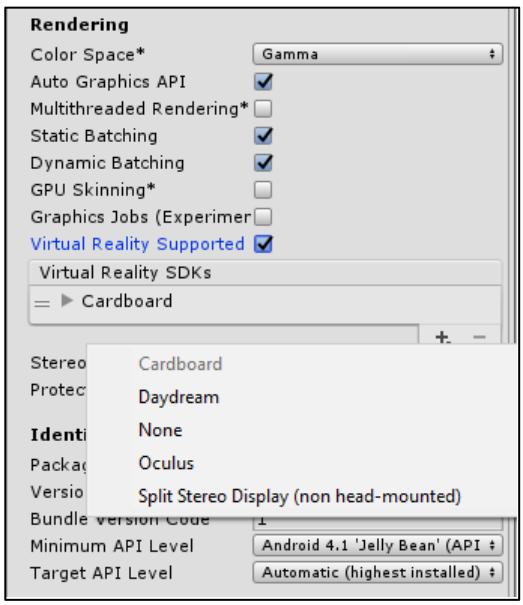

Figure. 4. VR Rendering

As this project is aimed to be a VR game, it is essential to be able to render the game in VR. In Unity 5.6, virtual reality rendering is natively supported. As shown in Figure 4, the 'Virtual Reality Supported' checkbox opens up a list of options that is

supported natively in Unity 5.6. Cardboard is chosen here as that is the target deployment platform.

4.2 Spatial Audio

This project's next core component is spatial audio. The spatial audio is used as cues that guides the player to where the enemy is coming from. This project utilized the Oculus Spatializer as the audio engine, as seen in Figure 5. This enables the audio source in the game world to render sounds based on their world coordinates.

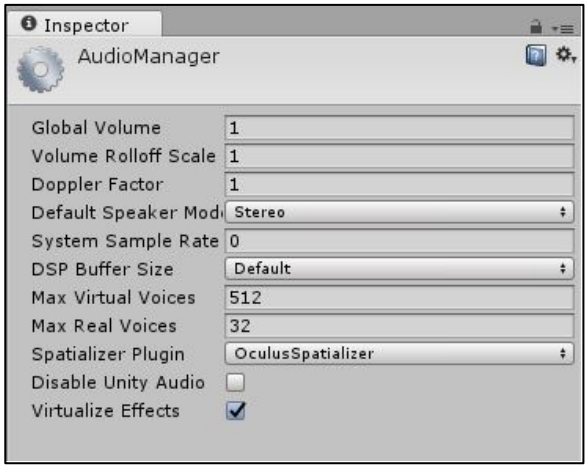

Figure 5. Audio Spatializer

4.3 User Interface

In VR, user interfaces (UI) should not be considered the same way as the usual interface for games. There are some challenges that VR developers have to take into account when designing UI for VR [5].

The design used in this game is one that is known as Spatial UI. This design positions the UI within the environment itself, by using World Space Canvas render mode in Unity 5.6. This will make it easier on the eyes of the player.

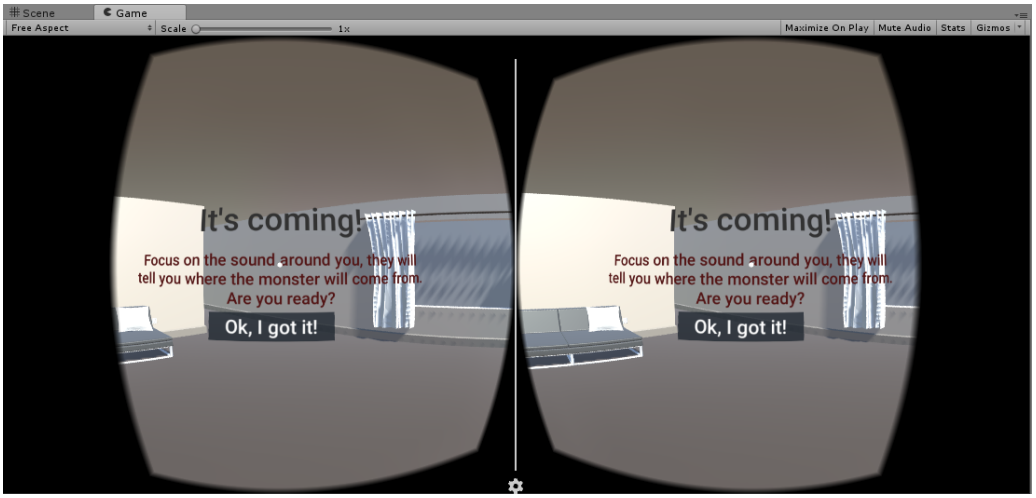

Figure 6. Game Instruction Using Spatial UI

The UI that greets the player once they enter the game is where you can see the Spatial UI being used. As seen in Figure 6, the UI is positioned at a comfortable reading distance, and is designed to follow the user's view. This is so that the player can have a chance to look around the environment and be familiar with it before starting the game, while also have the UI come into view whenever the player is ready to begin. After the button is clicked, the UI slowly fades out.

5 Results of the Project

This project results in an android based mobile game that uses VR and spatial audio technology. The game enters VR mode upon launch and players are able to experience it fully using a VR headset. In favour of experiencing the spatial audio element in the game, the player needs to equip their mobile phones with stereo headphones or earphones. This is a requirement to play the game, as the game uses spatial audio as interaction cues. The player needs to be aware while waiting for the directional sound cue to start playing the game.

This project is targeted to run on a minimum API level 19, which is Android 4.4 KitKat. Therefore, to ensure minimum compatibility, the game was tested on several smartphones to ensure the game works as intended. Table 1 shows the test with different smartphones.

Table 1. Platform Testing

Smartphone Model	Android Version	Successful Run
LG G2 D802	4.4.2	✓
Wiko FEVER	6.0	✓
Sony Xperia Z5	6.0	✓

A very important core component test of this project, is the spatial sound test. When implementing this technology, it is crucial to ensure the majority of the users are able

to pinpoint the direction of the sound cue for the game to be playable for them. The immersive experience also relies on the outcome of this test. Figure 7 shows the results of this test.

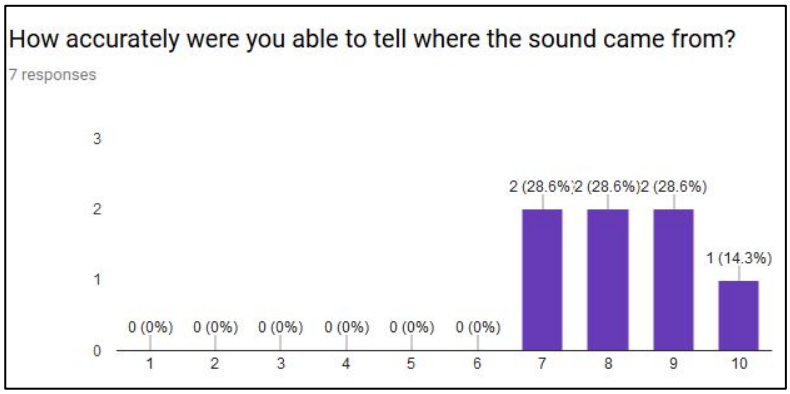

Figure 7. Spatial Sound Test

The spatial sound test had high scores from all the testers. With an average score of 8.286, the implementation of spatial sound with VR is successful. However, judging from the 57.2% users submitting scores below 9, there still is room for improvement. Sound engineering techniques could be implemented to enhance the sound immersion for future improvement. The final section of the testing is to obtain feedback from the testers, whether or not VR and spatial sound work great together and if the players enjoyed the VR experience in general. Figure 8 and Figure 9 presents the overall outcome of this test.

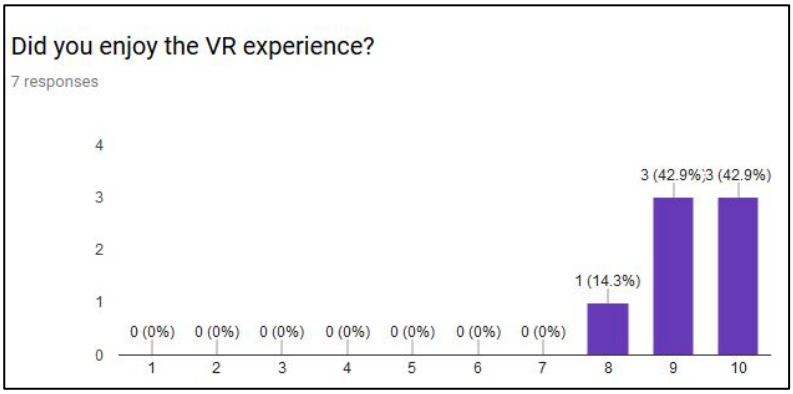

Figure 8. VR Experience Test

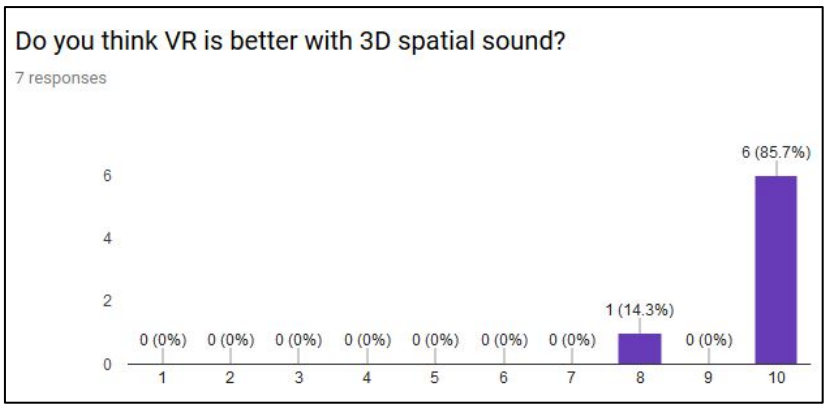

Figure 9. VR with Spatial Sound

As shown from the two bar charts in Figure 8 and Figure 9, VR is loved by a large portion of the testers. And all of them much prefer having 3D spatial sound together with VR for a more immersive experience.

6 Conclusion

This project was developed to blend in the latest technology which is Virtual Reality (VR) and the beautiful dynamic that a game presents. Together with the two, 3D or spatial audio were implemented to increase the technological height and immersion. This project is hoped to increase the amount of games developed in VR as well as expose more people to VR technology. It is also hoped to spark the market to keep moving forward and produce high quality VR content and games alike.

References

1. Begault, D. R., & Trejo, L. J. (2000). *3-D sound for virtual reality and multimedia.*
2. Sutherland, I. E. (1968, December). A head-mounted three dimensional display. In Proceedings of the December 9-11, 1968, fall joint computer conference, part I (pp. 757-764). ACM.
3. HTC Corporation. (2017) Vive. Retrieved 2017, from Vive, https://www.htcvive.com/us/
4. Berry, J. S., Roberts, D. A. T., & Holliman, N. S. (2014). 3D sound and 3D image interactions: A review of audio-visual depth perception. Human Vision and Electronic Imaging XIX.
5. Unity. (2017). User Interfaces for VR. Retrieved from: https://unity3d.com/learn/tutorials/topics/virtual-reality/user-interfaces-vr