# CT6APPVR Report

Background review of the Virtual Reality entertainment area.

## Entertainment area applications in Virtual Reality

One of the first Virtual Reality systems was developed in 1960-1962 by Morton Heilig who created a piece of hardware called *Sensorama.* Morton wanted to imitate an experience of riding a motorcycle so Sensorama provided a visual output as well as wind simulation, smell and vibrations. (Stanney, Allbeck, & Cannon-Bowers, 2002, pp. 1-4)

It was made to give people the feeling of immersion, a feeling of being somewhere else and not necessarily for entertainment purposes. From that time VR started to grow, and newer and much more advanced hardware was being invented, hardware that provided an illusion of participation in digital worlds or in other words a virtual clone of physical reality. (Mazuryk & Gervautz, 1996)

#### Games

Computer games are one of the more significant choices for providing an entertaining experience as the computer industry is huge right now, and still rapidly growing. Many games are being released every single day, and are constantly getting better at providing entertaining, interactive and more realistic experiences, especially now when Virtual Reality technologies are starting to be used more often in this area.

Virtual Reality application in this area offers things like the full view of the environment in any direction, allowing the user to look around virtual environments just like in the physical world whilst wearing a Head Mounted Display. It makes games immersive by creating a feeling of *being* inside a virtual environment.

The use of vr-specific input devices, such as the Leap Motion (Leap Motion, Inc, 2013) or VR treadmills creates an even greater illusion of being present in a different environment and gives the user the ability to interact with it using their body or its parts, instead of using buttons on keyboards/joysticks.

According to Wexelblat, stereopsis or binocular vision helps to provide an imagery illusion of depth at close range, where its effectiveness is at its highest. (Wexelblat, 2014, p. 107) To back this up, it was written in one of the articles of CyberPsychology & Behaviour that; *“Stereoscopy is a technique for creating the illusion of depth and 3D imaging while presenting a different image to each eye.”* In their article, they also wrote that they expected this technique to enhance the sense of presence in virtual environments. (BAÑOS, et al., 2008)

Projecting a stereo image that the brain will combine into an image that has more realistic depth, along with other depth cues (Bowman & McMahan, 2007, p. 39) is a technique that is being used by most of modern head mounted displays such as the HTC Vive (HTC, Valve Corporation, 2016) or Oculus Rift (Oculus VR, 2016) that have two image projecting lenses. Making the experience of VR much more entertaining by improving the quality of what user can see, even if it’s a slight improvement. But it also has it downsides, as most of the time it needs to be calibrated for every person and a high frame rate on the HMD’s has to be maintained, otherwise it can cause cyber sickness. Additionally, the field of view on HMD’s is reduced, an example of that could be the Google Cardboard, where the field of view is dependent on the size of the phone.

Additionally, when playing VR games the player gets the chance to play from the *real* first-person view, by wearing a Head Mounted Display. Whereas non-vr games that provide a “first-person” view are really second person, because the user is holding a controller or using other input devices to control their character. Instead of “being” a character themselves. (Craig, Sherman, & Will, 2009, p. 300) But it doesn’t mean that all VR entertainments focus on the user *being* the main focus of game. An example of that could be Edge of Nowhere (Insomniac Games, 2016) where the game is in third person.

Also, using some Head Mounted Displays such as the HTC Vive (HTC, Valve Corporation, 2016) for playing games allows moving in the virtual world the same way as in the physical one, with hardware limitations of course as the HTC Vive’s cable extends up to 5 meters. Furthermore, if the tracking cameras are placed at a greater distance than recommended by the manufacturers, they can lose tracking accuracy. Moving can also be done by using the standard input devices, such as joysticks or mouse and keyboard.

#### Creative expression

Another application of entertainment in virtual reality allows is being creative. In environments where that allow it, users can move and place objects freely, colour and draw and all of that is happening in three dimensions. (Craig, Sherman, & Will, 2009, p. 301)

So, for example after drawing a bunch of colourful lines making it an abstract piece of art in 3D virtual space the user can walk into its creation, explore it from different angles, and adjust. Experiencing something like that would be hardly achievable without VR and if it was, most likely it would have to take up lots of effort and time. An example of a program allowing drawing in 3D spaces could be Tilt Brush (Google, 2016). It is more of an artsy application for virtual reality but, it is very enjoyable for many people which also makes it entertaining. (Craig, Sherman, & Will, 2009, p. 301)

The technology used in this application is often the HMD’s and motion controllers, like the Tilt Brush (Google, 2016) that uses the HTC Vive (HTC, Valve Corporation, 2016)

#### Interactive Fiction

Virtual Reality can also be used by having a storyline where the user is being given choices in games that will affect the way the story continues. By letting the user decide what will happen next when in VR it might make games more entertaining, and less repetitive. Also, making it unpredictable even if you it was played a couple of times which might add new kinds experiences into the entertainment part. VR in this application would be used to make the user feel like they are a part of a story rather than just watching and not being in the scene, and VR also allows them to interact with the worlds using their body which makes it different from consoles. (Craig, Sherman, & Will, 2009, p. 300)

**Background research of previous work**

Virtual Reality is about aiming to create virtual experiences more realistic so they will affect people’s feeling of presence in them, also called immersion. By making virtual experiences more immersing could let the VR entertainment area expand quicker, adding VR in any form into our day-to-day life’s.

In *The Effect of Realism on the Virtual Hand Illusion* (Lin & Jörg, 2016)they write about how hand models with six levels of realism, and how those levels can trick their participants’ brains into thinking that their hand is present in the virtual world. This study was based on the rubber hand experiment (Botvinick & Cohen, 1998) but with the use of Leap Motion (Leap Motion, Inc, 2013) attached to an Oculus Rift (Oculus VR, 2016) In some cases the participants who were using the most anthropomorphic model have states that it reassembled their own hand in terms of looks, feelings and that the ability to move the virtual hand around also made them thinks it’s their real hand. (Lin & Jörg, 2016)

A different article was published at the same IEEE conference which was very similar in terms of immersion, in the *The Role of Interaction in Virtual Embodiment: Effects of the Virtual Hand Representation* (Argelaguet, Hoyet, Trico, & Lecuyér, 2016) the participants have used the same hardware as in the previous article, and had three hand representation models; a sphere, a hand representation ( that looked like a hand skeleton that was made out of bones ) and a realistic looking hand and forearm model. (Argelaguet, Hoyet, Trico, & Lecuyér, 2016)

In both articles the participants had to perform some actions and then were exposed to a threat to their virtual hand, in the first one it was a knife that was flying towards the participants. (Lin & Jörg, 2016) In the second article they were to perform some picking up of virtual objects using the virtual hand representations, and had obstacles that were a threat to the virtual hand (fire and a spinning saw). (Argelaguet, Hoyet, Trico, & Lecuyér, 2016)

After the experiments participants had to fill out questionnaires and in both articles, they stated that they had a sensation of the objects touching their hand in both environments. Just like in the previously mentioned rubber hand experiment. (Botvinick & Cohen, 1998) Furthermore, participants in most cases had an increased collision avoidance with the obstacles, and have been mentioning that the realistic hand model in both experiments gave them the biggest feeling of ownership of the virtual hand. It seemed that the realistically detailed model made people more likely to feel the ownership of the hand. Which suggests that making realistic assets in games will benefit the creation of immersive and entertaining experiences. (Argelaguet, Hoyet, Trico, & Lecuyér, 2016) (Lin & Jörg, 2016).

Also, a narrative in the virtual environments has an impact on immersion, in the questionnaire participants from the first article wrote that; *“he was not scared of the knife because he was controlling a zombie hand and he thought the knife was part of a Halloween theme, and another said he may have felt more surprise from the knife if he was not controlling the robot model.”* (Lin & Jörg, 2016)

**Future Research**

A research about real-time face and body tracking is being done by researchers from the University of Würzburg, Michigan State University and University of Cologne. The aim of their research is to find the best solution for creating a virtual replica of a human body, and use it as an avatar that has the appearance and behaviourism that the human body has, which cannot be yet achieved with the current VR technology. It could find it’s uses VR entertainment applications as well as in other VR areas most likely in applications that would have multiple players and allow social interactions in virtual environments (that could also be used in entertainment) as single player application wouldn’t necessarily need a full body avatar, but maybe just a representation of anything that the user is able to see. (Lugrin, Zilch, Roth, Bente, & Latoschik, 2016)

In this article, they discuss different options for hardware and software, including their costs, limitations and features that they must provide and comparing them against each other. They wanted to use either Unity (Unity Technologies, 2005) or Unreal Engine (Epic Games, 1998) for developing *FaceBo’s* prototype because they are frequently used for VR research and can provide high quality animations and appearance. (Lugrin, Zilch, Roth, Bente, & Latoschik, 2016)

After analysing their options, they chose to use the Carmine 1.09 (PrimeSense, Apple Inc., 2013) andMicrosoft Kinect v2(Microsoft, 2014)for the face and body tracking in combination with the Unity Engine (Unity Technologies, 2005) to create their prototype of *FaceBo* who they will keep developing to help with their research. (Lugrin, Zilch, Roth, Bente, & Latoschik, 2016)

## Technology used in the area

**Software**

Software in VR is used for handling the input and output data and managing the hardware, and its settings. I/O data must be managed with care because there is always a risk of destroying the immersion by for example, not having the orientation or the spacing of the lenses calibrated in HMD’s, or by using the wrong settings. Software also plays a crucial role in virtual reality because without appropriate software which can translate the data like the position, orientation or if buttons were pressed, touch etc. that can be used to be used to create virtual experiences with the use of different hardware. And without it, virtual reality would most likely not be as developed as it is now. (Mazuryk & Gervautz, 1996, p. 15)

Examples of software that is often used in development for VR nowadays could be the previously mentioned Unity (Unity Technologies, 2005) and Unreal engine (Epic Games, 1998) that support the use of HMD’s, motion controllers as it can be seen in their documentation. As well as Leap Motion (Leap Motion, Inc, 2013), Wizdish and possibly any piece of hardware. If there are no official plugins released, it should not be a problem to integrate the hardware into those two, or any other engines as long as the developer can access the source code that can control the hardware.

*Unreal Engine VR documentation and Release Notes:*

<https://docs.unrealengine.com/latest/INT/Platforms/VR/index.html>

<https://docs.unrealengine.com/latest/INT/Support/Builds/ReleaseNotes/2015/4_9/>

*Unity3D Engine VR documentation:*

<https://docs.unity3d.com/Manual/VirtualReality.html>

Hardware manufacturers often release the source code and documentation for their products that allow developers to create of their own software that supports any type of hardware that they might want to use. Or by integrating it into the previously mentioned engines in the form of plugins. Examples of source code that could be used by developers can be seen below.

*OpenVR* (Valve, n.d.)

<https://github.com/ValveSoftware/openvr/wiki/API-Documentation>

*OSVR* (Razer, n.d.)

<http://www.osvr.org/what-is-osvr.html>

**Hardware**

*“Hardware used in virtual reality systems can be roughly categorized as display devices, input devices that a user consciously activates, and input devices that monitor the user, along with the computer that supports the modelling and rendering of the virtual world.”* (Craig, Sherman, & Will, 2009)

The main piece of hardware that is required in most cases of virtual reality is a computer or a smart phone. It is required to be able to perform the calculation of physics, rendering shapes/objects via a graphics engine and handling the data from input/output devices. All of this at a low-to-zero latency which can reduce the effectiveness of the system. (Craig, Sherman, & Will, 2009, p. 10)

Visual displays are very commonly used output devices that allow us to see what is happening in the virtual environments via getting the visual output data from a computer.

Benefits of the CAVE systems are their large screens and the field of view that they provide, allowing users to have a 360-degree view of their surroundings and allow more than one person to use it simultaneously. The cons of CAVE are that usually it’s quite expensive as the number of projectors must be increased to improve the image quality (and graphics-rendering hardware upgraded) as well as it can be difficult to mask the real-world objects. (Craig, Sherman, & Will, 2009, p. 12)

Head Mounted Displays, are types of headsets that provide a stereoscopic image to its user’s eyes, and allow to look around them in any direction (called 100% field-of-regard). Modern HMD’s are light-weight when comparing them to the original ones, and as the technology progresses they are getting closer in size to a basic pair of sunglasses. But they do have their downsides, as they might cause headaches and nausea if they are not calibrated for each user, or if there is a low framerate. They are also much cheaper than the above-mentioned CAVE systems. (Craig, Sherman, & Will, 2009, p. 13) And smart-phone VR such as Google Cardboard (Google, n.d.) is even more cheaper, as it only needs a smart phone and a the Google Cardboard itself that can be bought for about £15.

Position sensing and motion tracking play a very important role in VR and come in many variants such as optical, gyroscopic (used in smart-phones in HMD’s) and ultrasonic (Wizdish) which are just a few types. Often they have limitations, and other type’s sensor should be used too/instead. For example optic sensors require a full, uninterrupted line-of-sight on the object they need to track, an example of one of these could be the Leap Motion. (Craig, Sherman, & Will, 2009, p. 18)

## Risks

Virtual reality comes with some risks such as getting injured, while experiencing an immersive virtual environment when wearing a HMD. The user might see things in the virtual world and try to move towards them, or try to touch them and hit something in the real world causing an injury. Or tripping over a cable that sometimes can attached to the HMD system while not sitting down during the experience. (Costello, 1997, p. 13) They endanger themselves as they put on the HMD, because they become *blind* in the real world. So it would be a good idea to remove any obstacles from the area to prevent tripping, or just have someone else watch the person who is watching the user.

As written in the hardware section above, VR can cause motion/simulation sickness that symptom in headaches, eye strains or nausea. (Costello, 1997)

In the articles Costello also writes that it was suggested that VR might cause hallucinations, dissociation and retreat from reality. Additionally, there was some concern that it might also affect the hostility of people after being often immersed in violent virtual environments. (Costello, 1997, p. 18)

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