Virtual Reality

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HG2052 Assignment 1

1. Introduction

Virtual reality, also known as VR, has gained attention as the new form of computer interaction (Wann and Mon-Williams, 1996). It is also known as part of web 2.0, which is the second-generation of web technology creating social networks (Wilson, 2006). The term 'virtual reality' was coined by Jaron Lanier, the then CEO of VPL Research, which manufactures gloves and goggles and other VR products (Steuer, 1992). It is defined as an electronically simulated environment aimed to stimulate an individual by feedback to create a realistic experience. The main goal is to generate an immersive experience that would be indistinguishable from reality through immersion and perception (Boas, 2013). VR has been described by researchers as a communication medium. Biocca and Levy (1995) even suggested that VR is likely to dominate as a communication medium. However, this description is problematic because there are single-user VR systems and conventional communication requires two or more participants (Riva, 1999). VR systems are being implemented in many disciplines like the military, gaming, sport and education. In 2018, Perkins Coie LLP, a global law firm, reported the investments each industry attracted for VR in a survey. Gaming attracted 59%, followed by education and healthcare, both attracting 26%, marketing at 20%, live events and military both at 19%, movies and retail both at 18% and manufacturing at 17% (Perkins Coie, 2018). Very often, VR is associated with the hardwares like Head-Mounted Displays (HMDs), gloves, and headphones. However, software developers, policy makers and researchers would debate against the concept of VR to be limited to only hardware (Steuer, 1992). The experience of VR can be explained in terms of human experience with the concept of immersion, presence and telepresence too (Boas, 2013)

1.1 Immersion, Presence and Telepresence

Immersion refers to how well the system is able to estimate movements and characteristics virtually. For example, if a virtual simulation of underwater experience includes sounds of snorkeling, visuals of marine life and ability for the user's movements to simulate swimming through the water, it will be considered highly immersive (Markowitz and Bailenson, 2019). The concept of presence, which refers to the experience of the physical environment via automatic and controlled mental processes, is important in VR as well. In addition to presence, another more specific and closely related concept is telepresence, which is term coined by Marvin Minsky (1980) to describe the perception of two separate environments at the same time, one in the present and another through a medium (Steuer, 1992). The compounding of 'tele' with 'presence' also suggests the idea of distant environment projection i.e. virtual reality. Although telepresence is an important concept in simulated environments, the evidence for this experience and impact is scarce (Draper, Kaber and Usher, 1998).

2. Earlier VR Inventions

One of the earliest known inventions of VR is the Sensorama, a mechanical device introduced by Morton Heilig in 1962. The Sensorama was a machine designed to provide an immersive experience using 3D visuals, sensory stimuli like audio, olfactory and haptic stimuli, and wind. The user would sit in front of a screen displaying a movie of a motorcycle travelling through Brooklyn. The sensory stimuli would allow the user to experience telepresence. However, the Sensorama does not allow interaction with the movie hence, it was unable to achieve full immersion (Boas, 2013).

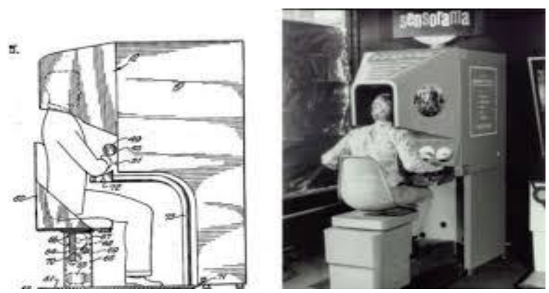

Figure 1: The Sensorama (retrieved from: https://learn.g2.com/history-of-virtual-reality)

Around the same period, the first Head-Mounted Display (HMD) called Headsight was produced by Philco, an electronics manufacturing company. The Headsight was a helmet equipped with a cathode ray tube display and tracking system. This was essential for the device to find the position of the user's head. The ability to track head movements would potentially allow the user to experience telepresence (Boas, 2013).

Figure 2: The Headsight (Retrieved from: https://courses.vrtl.academy/lessons/what-is-virtual-reality-and-where-does-it-come-from/)

Following the invention by Philco, Ivan Sutherland invented another HMD in 1968 called 'Sword of Damocles', a Binocular Omni Orientation Monitor (BOOM). In addition to the ability to track the user's head, the BOOM was able to track the user's eyes as well, allowing updates to be made to the image of the stereoscopic view (Boas, 2013). However, in contrast to the HMD, the BOOM is mounted to the ceiling. This will allow its orientation and position in space to be measured, counterbalancing its mass. In addition, the user is required to position the device manually (Cruz-Neira et al., 1992).

Figure 3: The Sword of Damocles (Boas,2013)

3. Technology and communication in VR

There are four technologies that are important for VR to work - visual, aural and haptic displays to create a fully immersive experience, graphics, tracking systems for the user's movements, and databases for the construction and maintenance of realistic models. Other supplementary technologies include synthesized sound, forces, haptic senses and devices to facilitate tracking (Brooks, 1999). These technologies could be delivered with the help of input and output devices like Head-Mounted Displays (HMDs), headphones, speakers and motion-sensing gloves. As discussed earlier, one of the earliest inventions of VR are the HMDs, which allows visual communication. Stereoscopic displays and tracking systems in HMDs allow the users to perceive 3D images wherever they move. One of the most well-known mainstream HMD developed recently is the Oculus Rift. This HMD is mainly used for gaming purposes. It processes data from 3-axis gyroscope, accelerometer and magnetometer to update images quickly, hence reducing image delay. Another visual technology that uses VR is the Cave Automatic Virtual Environment (CAVE). CAVE is VR projected on the walls of a room using projectors that display stereoscopic images. Users, however, will still need to put on electronic eyewear that are synchronized with the images (Boas, 2013). Input devices play a huge role in allowing users to experience immersion. Three of the most common input devices are the wired gloves, wands and cameras. Wired gloves allow the software to track movements, measure joints angles, pressure and haptic feedback via conductive ink to measure electrical resistance and mechanical sensors. Wands can track the user's movements by using triangulation to calculate the position of the user. Cameras can be used to recognize movements too, hence enabling interaction. One example is the Microsoft Kinect. It uses an RGB camera which allows facial recognition and scanning of surroundings by identifying objects of different tone and using machine learning to recognize the user's joints, allowing it to recognize it as the human body (Boas, 2013). Besides physical interaction using hardware, a handsfree system of communicating is possible with speech recognition as well. A hands-free system with speech recognition allows users to walk in a room and interact in the virtual environment by speaking to the system. The system will process the user's speech via natural language processing and respond via speech synthesis (Dorozhkhin and Vance, 2002).

4. Linguistic Features of VR Communication

4.1 Features of Communication

Speech	**Text**	**VR**
Time bound	Space bound	**Time bound**
Spontaneous	contrived	**Spontaneous**
Face-to-face	**Visually decontextualized**	**Visually decontextualized** **Face-to-Face** (depending on interface)
Loosely structured	Elaborately structured	**Loosely structured**
Socially interactive	Factually communicative	**Socially interactive**
Immediately reversible	Repeatedly revisable	**Immediately revisable**
Prosodically rich	**Graphically rich**	**Graphically rich**

Table 1: Comparison of VR with speech-like and text-like medium based on Crystal (2006)'s seven features of communication.

Comparing speech-like and text-like communication medium with VR using Crystal (2006)'s features of communication, we can observe that VR is more similar to speech-like than text-like communication medium. VR, like speech, is time-bound, spontaneous, loosely structures, socially interactive and immediately reversible. This is largely due to the fact that interaction in VR occurs in real time. However, VR is both face-to-face and visually decontextualized. VR systems that allows reconstruction of humans in virtual environment would allow face-to-face conversations between 2 or more users online. Very much similar to speech-like mediums, virtual humans communicating with each other in VR combines both verbal and non-verbal gestures like intonation, eye gaze, gestures and head movements (Gratch et al., 2002). Even if the human can be virtually represented by non-human avatars in the virtual environment, conversation between users in a multiuser VR system would require speech as well. Although non-verbal gestures would be eliminated, prosody in speech will still be present. On the other hand, if the VR system is single user, it would eliminate the idea of face-to-face interaction, hence, visually contextualized. As VR is largely based on stereoscopic images, it is rich in visuals. Hence, it is graphically rich.

4.2 Virtual Linguistic Landscape

As more and more industries adopt the usage of VR, it is not surprising that the VR environment would become increasingly multilingual. Linguistic landscape is a sociolinguistic concept which refers to how language is used in an urban setting, particularly in a multilingual environment. For example, physical spaces like public signs like street names, public transport and commercial signs. Linguistic landscape in a virtual environment is also known as virtual linguistic landscape. This refers to the identity marker for textual access and expression in the cyberspace. In virtual linguistic landscape, words used in the physical world is used to describe areas of interest in the virtual world. For example, virtual *tour*, information *highway*, chat *room*. This creates a conceptual relation between the physical world and virtual environment, supplementing immersion. Language used in the virtual linguistic landscape allows less spoken languages to be revived too. The virtual environment is able to find new ways to repackage languages creatively and create a linguistic ecology, allowing possibilities for new interaction that is not represented in the physical world. For example, Latin, a language described as ‘dead’ , could be revived if used in the virtual environment and used in online conversations. (Ivkovic and Lotherington, 2009)

5. Application and Usefulness of VR System Implementations

One of the most common applications of VR is for training purposes in the military. Vehicle, flight and soldier training are the most common kinds of VR usage (Boas, 2013). Vehicle simulations involve ground and water.

For ground vehicles, navigations of heavy armored vehicles and communication scenarios are most commonly simulated. For water vehicles, submarines are simulated. However, unlike ground or air vehicle simulations, submarines do not require much visuals. The simulation is more for training reading of underwater movements. Soldier training is designed to resemble video games. Flight VR simulators are one of the earliest implementations of VR in the military (Lele, 2011). Flight simulators come in two different forms - computer monitors with projected images of airplane views, or a simulation cockpit (Boas, 2013). Both methods require high performing software and haptic feedback in order for the best experience.

Figure 4: Flight simulation cockpit (Boas, 2013)

There are many advantages from the implementation of VR in the military. Firstly, it provides a much safer and cost-effective way of training (Lele, 2011). Secondly, the simulation can be repeated without compromising safety. Thirdly, the trainees can simulate difficult scenarios without risks (Wilson, 2006). In addition, on-the-job training is not possible because of involvement of possible warfare (Lele, 2011). VR systems have been implemented in the entertainment industry as well, using stereoscopic technologies in movie theatres. VRs on smartphones are capable of generating haptic feedback too. The Oculus Rift, a HMD, is no stranger and has taken the gaming world by storm when it was released (Boas, 2013)

In addition, VRs systems have been implemented in empirical research. In Pertaub et al. 's 2002 findings on virtual public speaking, they discovered that psychological effects of public speaking are inevitable, regardless of being perceived as virtual avatars or not. Subjects with high anxiety were asked to speak publicly to a group of audiences in VR via avatars. Despite not showing their actual faces, the subjects were still highly affected when negative feedback was received from their virtual audiences (Pertaub et al., 2002). Another example is the usage of VR for research on multimodal interactions. Pfeiffer (2012) and team were able to replicate a study on the communication accuracy and precision of pointing gestures between interlocutors by using maker-based tracker system on the VR system and produce results that are more accurate and hence, producing a better model of the study (Pfeiffer, 2012)

6. Conclusion

VR’s technological advancements has come a long way since the Sensorama and has since invaded multiple industries. The concept of presence and telepresence allow humans to fantasize about worlds beyond reach and limits, blurring the lines between human and machine. As a communication medium, VR has successfully proven to be versatile and useful in accommodating the inevitable by being costefficient and reducing risks, particularly for military use. However, there are limitations for the usage of VR. Ideally, the VR simulator should be in a cool environment to maintain the equipment, but it should not be cold or wet otherwise it might cause physical stress to the user (Wilson, 2006). This would make installing and maintaining of the system expensive and tedious. As full immersion VR systems are still not possible because of the lack of understanding on the human consciousness, it would be hard to determine if VR is truly useful in creating a simulation that can replace the physical world. Nonetheless, VR is moving fast in the tech industry. eMarketer, a market research company, predicts that there will be a consistent growth in VR users between 2020 and 2021, based on previous trends (eMarketer, 2019). Regardless, with technology advancing at an exponential speed, it might not take long for VR to transcend its capabilities and allow the lines between reality and fantasy to be blurred.

7. References

Boas, Y. A. G. V. (2013, August). Overview of virtual reality technologies. In *Interactive Multimedia Conference* (Vol. 2013).

Brooks, F. P. (1999). What's real about virtual reality?. *IEEE Computer graphics and applications*, *19*(6), 16-27.

Cruz-Neira, C., Sandin, D. J., DeFanti, T. A., Kenyon, R. V., & Hart, J. C. (1992). The CAVE: audio visual experience automatic virtual environment. *Communications of the ACM*, *35*(6), 64-73.

Dorozhkin, D. V., & Vance, J. M. (2002, January). Implementing speech recognition in virtual reality. In *ASME 2002 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference* (pp. 61-65). American Society of Mechanical Engineers Digital Collection.

Draper, J. V., Kaber, D. B., & Usher, J. M. (1998). Telepresence. *Human factors*, *40*(3), 354-375.

Gratch, J., Rickel, J., André, E., Cassell, J., Petajan, E., & Badler, N. (2002). Creating interactive virtual humans: Some assembly required. *IEEE Intelligent systems*, *17*(4), 54-63.

Ivkovic, D., & Lotherington, H. (2009). Multilingualism in cyberspace: Conceptualising the virtual linguistic landscape. *International Journal of Multilingualism*, *6*(1), 17-36.

Lele, A. (2013). Virtual reality and its military utility. *Journal of Ambient Intelligence and Humanized Computing*, *4*(1), 17-26.

Markowitz, D., & Bailenson, J. (2019). Virtual reality and communication. *Human Communication Research*, *34*, 287-318.

Pertaub, D. P., Slater, M., & Barker, C. (2002). An experiment on public speaking anxiety in response to three different types of virtual audience. *Presence: Teleoperators & Virtual Environments*, *11*(1), 68-78.

Petrock, V. (2019, March 27). Virtual and Augmented Reality Users 2019. Retrieved February 28, 2020, from https://www.emarketer.com/content/virtual-and-augmented-reality-users-2019

Pfeiffer, T. (2012, March). Using virtual reality technology in linguistic research. In *2012 IEEE Virtual Reality Workshops (VRW)* (pp. 83-84). IEEE.

Poetker, B. (2019, September 26). The Very Real History of Virtual Reality (A Look Ahead). Retrieved February 28, 2020, from https://learn.g2.com/history-of-virtual-reality

Riva, G. (1999). Virtual reality as communication tool: A sociocognitive analysis. *Presence*, *8*(4), 462-468.

Steuer, J. (1992). Defining virtual reality: Dimensions determining telepresence. *Journal of communication*, *42*(4), 73-93.

Wann, J., & Mon-Williams, M. (1996). What does virtual reality NEED?: human factors issues in the design of three-dimensional computer environments. *International Journal of Human-Computer Studies*, *44*(6), 829-847.

What is virtual reality and where does it come from? • VRTL. (2018). Retrieved February 28, 2020, from https://courses.vrtl.academy/lessons/what-is-virtual-reality-and-where-does-it-come-from/)

Wilson, C. (2008, April). Avatars, virtual reality technology, and the US military: Emerging policy issues. Library of Congress Washington DC Congressional Research Service.