HCI/UXD Research Report
on
Virtual Reality in Games

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1. Introduction

Virtual Reality is as the name suggests - a computer-generated dimension that people can interact with and in. The concept has been around near the birth of the internet but has not not been fully implemented until the last decade, when technology has caught up with dreams and ideas shown in books and movies.

There are a lot of applications virtual reality can be used for (Applications of Virtual Reality, n.d.). This report will cover the major uses quite generally and then focus on the gaming industry, the research behind it, the positives and negatives, and a prediction for the future.

2. Uses of Virtual Reality

2.1. Education and Medicine

With the current generation of children growing up around technology, education can be more than sitting silently in a classroom taking notes; being able to provide another environment to the subject can generate new interest in the subject and explore ideas that were only theoretical. One such example is grabbing raw chemical elements and combining them together to create stuff (Tablecraft, n.d.). This can be applied to many subjects and generate new interest within school children to take those subjects into further education. There is a slight problem that can be foreseen with the children who grew up learning like this becomes too reliant on such technology.

In the case of medicine, students can practice surgery or dentistry in a controlled virtual environment as many times as they like. Training in virtual reality also allows the development of motor skills, and if any part of the training goes wrong, the consequences are not so dire compared to practicing in real-life. After being comfortable training in the virtual world, the difference between real practice and virtual practice will not feel as big as reading from a textbook to touching a human person.

2.2. Psychology and Therapy

Virtual Reality can help psychologists and therapists immensely, allowing patients to begin the healing process on psychological disorders like ptsd in an extremely safe, comfortable and controlled environment, both virtually and in their real surroundings. It can also help patients to overcome many phobias by using virtual reality exposure therapy (VRET), and also introduce virtual experiences to people they may never be able to do: wheelchair-bound patients rock-climbing, scuba-diving, and being able to introduce the overview effect to younger generations.

2.3. Military Training and Rehabilitation

Application for military-usage can be extensive and being able to train soldiers to be as combat-ready as possible without putting them in any active harm is a very lucrative investment. This will allow soldiers to react in a certain way that prevents any loss of life. Simulations in planes, tanks, submarines, and any other expensive vehicles will cut massive costs and allow the money saved to be used elsewhere.

Another unfortunate but useful usage is rehabilitation. Helping patients cope with being in a wheelchair or the loss of a limb helps soften the mental impact by putting them in a game-like virtual environment, and the environment can also change extensively and help patients cope with situations they will unlikely come across. Re-learning how to use muscles after an accident can aid the physical therapy and also reduce the workload of doctors and nurses when patients also have a virtual personal assistant.

2.4. Workplace Training

As previously mentioned, military simulations can extend to other workplace environments. Training new people how to use expensive machinery without using the actual machinery will allow massive costs to be cut, less accidents to occur, and more training time allowed than ever before. The simulations can go over safety procedures and checklists, and visualise accidents if they actually happened to deeper ingrain in the memory than reading about it.

2.5. Cinema and Games

The entertainment industry has been the driving point of virtual reality. From 360 video, 3D video, (acknowledgement to the pornographic industry) and video games using many different types of headsets to achieve a more immersive experience.

360 video is where the viewer “becomes” the camera. The camera is recording at all possible angles and then the viewer can then “look around” by turning their heads. Creators often allow viewers to give a behind-the-scenes experience from the comfort of their homes by giving viewers one focal point and allowing them to peek around if interested. Having too many things going on at once can disorientate and confuse the viewer.

3D video is a 2D video in either a screen or in virtual reality. The viewer can then interact with the video - spin it around, scale it up or down - and this works best with 3D models. This is very similar to augmented reality and they both give the viewer the ability to see as it would be in real-life. It gives a sense of scale, viewpoints from all angles, saving on actual material being built, and potential simulations to interactions with the environment.

The gaming industry is another market VR's popularity is growing. Some companies are capitalising on this wave, with only a few headsets being made and dominating the market already. The companies try to make the development for their technology as easy as possible - providing documentation and support, which then in turn, allow game developers to create new games which capture the interest of the public gaming community. Examples of popular games are Beat Saber - a lightsaber music rhythm game (Beat Saber on Steam, 2018). - and GORN - a bloody, gladiatorial combat game (GORN on Steam, 2017).

3. Different Types of Headsets

3.1. HTC

HTC has released a headset called Vive.

HTC Vive (2016)

This company only produces for the PC market. This has its positives and negatives as the company can truly focus on their product - regarded as the best virtual reality headset to buy, but unable to tap into other devices like mobile or console. HTC has also partnered with the biggest digital distribution platform Steam, and making their headset integrated as much as possible with Steam.

The two black boxes are "Base Stations" and on the headset itself - a tracking system and a separate front camera. They all work together to allow the player use the physical environment around them to create the best gaming experience possible either seated, standing, or the entire room while safely navigating around. Also included is a gyroscope to track the player's rotational movement in-game. The controllers have multiple input methods

and buttons to provide as much precise control and feedback as possible. The controllers are also tracked to determine where they are in-game. (HTC Vive, 2016).

3.2. Oculus

Oculus has released four different products:

- Oculus Rift - a VR headset for PC.
- Oculus Go - a stand-alone virtual reality headset.
- Gear VR - a partnership with Samsung to develop a headset just for its smartphones.
- Oculus Quest - a stand-alone virtual reality console.

Oculus Rift (2016)

The Oculus Rift is a virtual reality headset for PC gamers. The headset has integrated headphones providing real-time surround-sound audio effects and has a gyroscope. The controllers are simple in comparison to the HTC Vive but works just as well. The sensors track the headset and controllers, determining the rotational and positional coordinates for all devices, and there is the option to buy more sensors instead of just using the two it comes with to provide a more three-dimensional depth (Oculus Rift, 2016).

Oculus Go (2018)

The Oculus Go is a stand-alone virtual reality headset. It does not need a computer or smartphone to work, and is able to watch live events, films, tv and play smaller games with its single controller. The controller can be moved like a laser pointer, and the headset has inbuilt audio speakers with an audio jack (Oculus Go, 2018).

Gear VR (2015)

The Gear VR is like the Oculus Go, but with a partnership with Samsung, the Gear VR is specifically designed to use in tandem with its Samsung flagship smartphones. The smartphone is slide into the front-slot where the camera would normally go, and because of that, the headset is quite basic compared to the others - not having gyroscope or inbuilt speakers - due to using that functionality from the smartphone itself. In addition to the headset, additional accessories can be bought - a controller and or a gamepad to play games (Gear VR, 2015).

Oculus Quest (2018)

The Oculus Quest is a stand-alone virtual reality headset. It is essentially the first virtual reality console system, and it is similar to the Oculus Rift without the need of a PC. A new technology is developed to track the player's virtual space without the need of physical external sensors (Oculus Insight, 2018). With inbuilt speakers and battery, in addition to the controllers being battery-powered and tracked by the headset, everything will be wireless and will allow the player to jump and move around freely while still being aware of the physical surroundings around them being portrayed virtually (Oculus Quest, 2018).

3.3. Google

Google has released two different products:

- Google Cardboard - a stand-alone virtual reality headset.
- Google Daydream- a VR headset for PC.

Google Cardboard (2014)

Google Cardboard is a low-cost head-mount for android smartphones to encourage interest and development in virtual reality. Users can create their own or purchased an already-made one online at a very low cost. The head-mount itself is nothing special - a holder for the smartphone, two bi-convex lenses, and temple tips so the user can wear the head-mount. The mount can be made more comfortable with rubber or cloth pads.

Google has support for three systems - Android, Unity game engine, and iOS. The low cost and support for major software development systems makes it very attractive to develop simple software and games for Google Cardboard. The most simple usage is to watch media or play games that use the smartphone's gyroscope main and only controller - a dot is in the middle of the screen and if the dot is over a button, then the button will activate. To select different parts of the screen, the user's head is moved to the position necessary. This mechanic is carried forward to the simplest games, but more complex games can be played with the additional purchase of a bluetooth controller. Following its initial success Google announced its successor two years later, Google Daydream (Google Cardboard, 2014).

Google Daydream (2016)

Google Daydream is an upgraded version of Google Cardboard - more comfortable with fabric coverings and a custom bluetooth remote which can be held horizontally or vertically depending on the usage. Development support is still the same, and is more versatile than Gear VR since Google Daydream can support a lot of Android smartphones while Gear VR is only Samsung (Google Daydream, 2016).

3.4. PlayStation

PlayStation has released a headset called PlayStation VR.

PlayStation VR (2016)

The PlayStation VR is an accessory to its main console. The headset has inbuilt audio speakers, gyroscope sensors and numerous LEDs (which the controller also has in the button pad) all around the headset including the front and back to help the external camera track where the player is ingame.

The controller has a button pad right in the middle which adds extra control in the game. Using the controller with the headset generates a new experience for several games. For instance playing a flying game where the player flies and shoots with the controller - without the headset, the camera will move the direction the plane is flying. However with the headset the camera is dynamic, meaning the plane can be flying and shooting where the controller is directing it, but the player can look around the cockpit whilst doing so. This expands the experience players are normally used to and makes the player really feel like they are flying the plane.

An addition gun-like controller can be bought and used instead of the normal controller for shooting games to add more “authenticity”. The games released are quite stationary in contrast to the other VR Headsets because the physical movement is taken out and replaced by controllers. With the camera light sensor tracker and motionless of the player, couch co-op can be played - the main player using the headset and other players using normal controllers. This new type of gameplay is quite novel for both developers and gamers (PlayStation VR, 2016)

4. Studies and Research

4.1. Virtual Reality Exposure Therapy

Using virtual reality to combat specific phobias like panic disorder, social phobia, fear of flying, fear of spiders, and fear of heights - was the preferred method amongst patients and already proved effective from several studies. The current study analyzes virtual reality treatment in comparison to in vivo exposure and controlled conditions. The meta-analysis of 13 studies supported the hypothesis that VRET would outperform control conditions on fear-specific measures (Powers and Emmelkamp, 2008).

A number of studies combined VR treatment with cognitive techniques but the combined cognitive-VRET treatment was not more effective than VRET alone. There were also a number of limitations placed on previous studies as not being realistic or immersive enough, and so the fear response was not triggered enough (Powers and Emmelkamp, 2008).

As a conclusion, VRET is considered a highly-effective treatment, more-so than the other treatments, and also offered several a number of advantages. The treatment can be conducted in the therapist's office, in a safe environment virtually and in their real surrounding areas, rather than go outside in real phobic situations. Also, VRET can generate gradual assignments and introduce patients in a slow and gradual manner, and can also be repeated countless times in a number of infinite different scenarios, to patients who are too anxious to undergo real-life exposure in vivo (Powers and Emmelkamp, 2008).

4.2. Rehabilitation of Motor Disorders

Several games were developed to build a virtual reality based therapeutic training system for stroke patients with upper limb motor disorders to practice physical exercises. The use of virtual reality and computer games in motor rehabilitation have been expressed in how it would be an effective and enjoyable way to work through physical therapy. Several other studies have identified the benefits of using virtual reality to improve balance, endurance, dexterity, speed and range of motion. Most virtual reality applications in rehabilitation simulate real life activities or performing everyday tasks, but not physical simulation. Physically-based simulation creates realistic motions of virtual objects based on the laws of physics, so virtual objects and their responses to external force and torque respond in realistic manner (Ma, McNeill, Charles, McDonough, Crosbie, Oliver and McGoldrick, 2007).

An adaptive virtual reality "whack-a-mouse" game was created to improve overall movement, the accuracy and speed of users' upper limb movement, and the patient's visual discrimination and selective attention. The game was configured to the patient's profile and progressively grew more difficult, and the data - score, accuracy rate, and length of gameplay sessions - were continuously recorded to give both the patient accurate feedback, and the physiotherapist diagnosing the healing process and how many sessions left would be required. This dataset and other datasets were used to accurately progress the patient so

it would not be too difficult but yet not too easy (Ma, McNeill, Charles, McDonough, Crosbie, Oliver and McGoldrick, 2007).

Patients enjoyed playing the game, and the paper showed how adaptive virtual reality games can contribute to motor therapy by providing tasks that can automatically adapt to each individual patient's capabilities. The limitless variety of environments and games that could be generated can easily sustain and replace a large number of physical therapy, and at a much lower cost as well (Ma, McNeill, Charles, McDonough, Crosbie, Oliver and McGoldrick, 2007).

5. Conclusion

Doing this research on virtual reality, and being able to play some games using the PlayStation VR has had me thinking about the possibilities of this technology in the future. I think the main attraction is also the biggest drawback. Complete immersion of two of the five major senses can have its positives - really feeling like you're part of the game, being able to experience something as realistically as possible, and possibly doing things you could never do, also has its negatives.

The negatives being motion sickness, or becoming so immersed that you lose track of time and or not being able to respond promptly to any outside world emergencies, and currently with all the equipment being so cumbersome is itself a safety hazard.

Many games for virtual reality try to include physical movement so new equipment like the Omni-Directional Treadmill was created to solve the issue. The problem is that it is too expensive, big, and heavy for the average homeowner. People are already having to dedicate an entire room just for virtual reality gaming.

However I think virtual reality can still be a viable option and won't be a dying trend, if the technology improves in the future like so:

- Technology like Oculus Quest becomes mainstream - that will reduce the number of electronics to be carried around.
    - Instead of a big bulky headset, the technology can fit inside something as small as Google Glass - it will still provide the immersion due to covering the eyes like swimming goggles, but will not be heavy and easy to take off and on.
    - The audio system can be part of the temple tips, or easily heard with external earphones.

- Currently, virtual reality can only be accessed as stand-alone, or through a smartphone, or a pc. The best way (if it is even possible) would be for it to be a stand-alone console that can also pair up with either the PC and or smartphone.

- Sensor technology improves to the point where gloves can be worn to track fingers/hand placements ingame and not having to carry around extra controllers.

Even with all the technological improvements proposed, there is one final barrier and that is physical space. The average homeowner won't have an extra room to dedicate to virtual reality gaming, and installing something like the Omni-Directional Treadmill is fairly permanent and still has some safety hazards.

One solution would be to develop motionless games, but that takes away the immersion of VR. Another solution would be to upgrade current arcade centers and have a new generation of gaming, while still being able to rent timeslots out for special medical, military, or workplace training. The arcade centers will be able to have the latest technological advancements while still generating income, and they can have dedicated space around each system. Players actively gaming will not have to worry responding to external stimuli because the arcade could override the game if there is any emergency; and socially, people will meet new and more other people while still being fairly active.

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Appendix

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