

Virtual



Reality

Topic Number 11

Group Number 16

CS4182

History of Virtual Reality:

Virtual reality has an interesting history, the idea of VR technology was first proposed by a sci-fi writer named Stanley G. Weinbaum in his short story *Pygmalion's Spectacles* written in the 1930s. He wrote of a pair of goggles that allowed the user to experience a fictional world. Following this in 1955 a man named Morton Heilig envisioned a multi-sensory theatre in his paper entitled "The Cinema of the future", he went on to build a working prototype in 1962. It was called the Sensorama and is one of the earliest known examples of a virtual reality system. It was a large device that you could place your face into. It simulated a motorcycle ride through New York, the user would sit in an imaginary motorcycle, with fan-generated wind, and simulated noise and smells of the city. Despite the lack of user control the experience still felt real. Heilig believed his invention could also be used to train the armed forces, he gave an example of a supersonic jet. Allowing students to experience flying the jet without putting them in danger. Heilig also patented a design in 1960 called *The Sword of Damocles* and it is considered the first virtual reality head-mounted display. The drawings of it look incredibly like the VR technology we see today.

As the years progressed a man named Ivan Sutherland inspired by Heilig detailed the idea of an "Ultimate Display" in 1965. This device would be able to simulate a virtual reality to the point that the user would not be able to tell the difference from actual reality. "The ultimate display would, of course, be a room within which the computer can control the existence of matter. A chair displayed in such a room would be good enough to sit in. Handcuffs displayed in such a room would be confining, and a bullet displayed in such a room would be fatal. With appropriate programming such a display could literally be the Wonderland into which Alice walked." – Ivan Sutherland. Obviously as it was only 1965, the technology available made it impossible to create such an impressive piece of technology.

The idea of a virtual world indistinguishable from our own, sparked ideas in the minds of inventors in the years to come. Like American computer artist Myron W. Krueger, who created *Videoplace*. This was an artificial reality that surrounded the user, it also responded to their movements without needing goggles or gloves, the user would be projected onto a screen in front of them, they could change the image of themselves by moving around.

Later in 1991 we began to see virtual reality machines that were accessible by the public, *Virtuality Group* launched VR arcade games. Players would wear goggles and play immersive games. Some of the machines were networked together allowing multiplayer. Following this was the *Nintendo Virtual Boy* in 1995, with a head mounted display and "3D" graphics. The console was released but ended up being a commercial failure. This was since it was difficult and uncomfortable to use. After this the movie *The Matrix* was released in 1999, a movie about a virtual world. This movie inspired many to invest themselves more in virtual reality. This brings us to 2012 when the *Oculus Kickstarter* was created, the *Kickstarter* raises 2.5 million and essentially influenced most of the large tech companies to create the VR technology that we see today.

What is VR?

VR is an acronym for 'Virtual Reality' and is an advancing form of technology in the modern world. It is most commonly known for its involvement in the video game industry, even though the technology can be used for other purposes as well. It is currently being implemented to other entertainment industries and is even being used for education in some facilities around the world.

"Virtual reality is a synthetic technology combining three-dimensional video, audio, and other sensory components to achieve a sense of immersion in an interactive, computer-generated environment." - (Heim, M. (2014) Virtual Reality. Encyclopedia of Aesthetics [online]. Available [here](#) or [here](#))

The most common image that relates to VR is the headset you see people wearing like goggles, yet VR is often made up of a wide variety of equipment to cater for as many human senses as possible. For example, motion trackers can be used to follow the users' head and body movement to give both control and immersion to the user. Headphones, or other sound systems, are often used alongside the headset too. Sometimes sensors are used to indicate to the user that they are nearing a wall or object in their physical space.

VR games over the past few years have opened up a new market for the industry with their immersive gameplay design and equipment. Unfortunately, commercial VR is limited to a small community of people thanks to the cost of the hardware needed. Although optimisation of VR games allows them to run on a wide variety of computers/consoles, a lot of VR games when compared to standard monitor games have a significant, minimum demand from users' systems. This is usually the case since more processing, graphical and memory input is often required to play these games comfortably.

The equipment used in Virtual Reality is quite similar to what Augmented Reality uses, however both can be considered as two completely different industries. They are often mistaken for each other as they both may be used with headsets. The following quote from the article 'People About Virtual Places: A Qualitative Perspective' discusses the differences between the two quite well:

"In augmented reality (AR) environments, users experience the physical environment and other users directly along with mediated virtual objects embedded in the environment. In immersive virtual reality (VR), users experience of a visual environment (and sometimes other senses) is completely mediated." – (People About Virtual Places: A Qualitative Perspective [online], p. 204, Available [here](#))

VR Hardware Available Today

Just like many other technologies and commercial products, a wide selection of VR headsets and hardware is available to the public. In this section I hope to give a summary of just a few of these VR products along with their expenses.

The Valve Index

The Valve Index is one of the most advanced and, understandably, most expensive VR kits available to the public today. It is relatively new at the time of writing this as it was released on the 28th of June 2019.



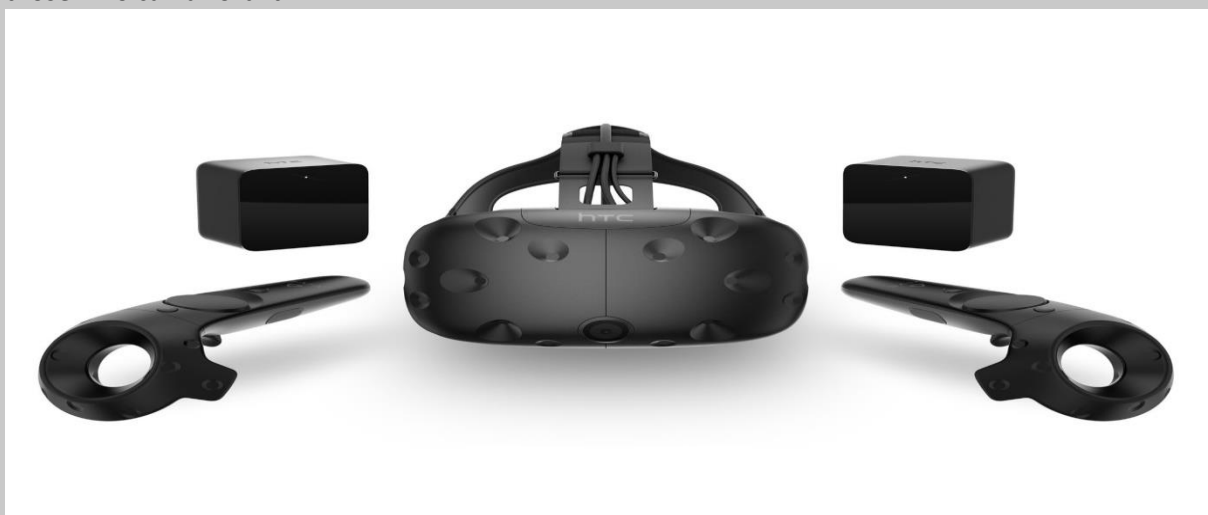
As seen in the image, this VR kit includes a headset with built-in headphones, one controller for each hand and two 'SteamVR 2.0 Base Stations' which track the user. The headset has a 1440 x 1600 liquid-crystal display per eye and allows the user to adjust the field of view to their preference. The Valve Index controllers also contain sensors that track each individual finger of the user's hands, allowing for a more immersive experience when compared to other VR controllers.

At the time of writing, the Valve Index kit is at a cost of €1,079 if bought from Valve itself. Unlike some other VR kits though, the Valve Index allows users to test their PC from the store page using downloadable software, alongside giving a list of minimum components and specifications needed. This allows potential buyers to ensure that their computers are ready to run the Valve Index before committing to buying.

Additional information on the Valve Index can be found at both the [Steam Store Website](#) and the [Valve Software Website](#).

The HTC VIVE

In terms of VR in modern day gaming, the HTC VIVE would be a mid-range VR kit to own. It lacks some of the features that the Valve Index VR kit brings but still offers a Virtual Reality experience to those who can afford it.



The VIVE VR kit includes a headset, base stations and controllers as shown. Unlike the Index however, it does not have built-in headphones to the headset. The headset contains a dual 1080 x 1200 AMOLED 3.6'' diagonal display with a refresh rate of 90 Hz. Similar to the Valve Index, the VIVE also allows for adjustable field of view to match the user's preference.

Since its release in 2016, the HTC VIVE kit can be obtained for a wide variety of prices depending on the seller. Its minimum component specifications are only slightly lower than that of the Valve Index and HTC too allows users to test their hardware using downloadable software. From the VIVE Store page, this VR kit can be bought for the price of €599.00.

Additional Information on the HTC VIVE can be found at the [VIVE Website](#).

PlayStation VR

Unlike both the Valve Index and HTC VIVE, PlayStation VR is designed for the PlayStation 4 console and is not officially supported on PC. When compared to the other two VR kits, PSVR would be on the lower end in terms of a gaming Virtual Reality experience.



The PSVR kit includes the PSVR headset, PlayStation Move motion controllers and a PlayStation Camera to track the user. It does not include headphones and the controllers offer very little more in terms of immersive design when compared to the standard PlayStation Dualshock 4 controllers. The headset has a 1920 x 1080 5.7'' OLED display and allows for some adjustment to the field of view.

The PlayStation VR kit cannot be bought directly from the PlayStation Store page however, making the price vary significantly. It is currently available at [Gamestop](#) for €299.99, and a PlayStation 4 console is required to use it.

Additional information on PlayStation VR can be found at the [PlayStation Store](#).

How does Virtual Reality work?

Virtual Reality simply put is the act of trying to combine the physical world and the virtual and making them indistinguishable from each other. With the invention of HD screens, the difference between an image on screen and in real life has become indiscernible. This is very important because our brains are largely designed around our sense of sight making a virtual world seem like our own would mean having to deceive our eyes. The way designers involved in the development of virtual reality systems accommodate this sense today is through head-mounted devices providing auditory feedback which may also be used in tandem with haptic systems which give users force feedback and touch interaction. Physical Movements are recorded with 3-D sensory trackers and then the feedback of head, hand and body movement is sent to the screen to make movement feel seamless and real (*GC Burdea 2003*).

For 3-D sensory technology to work the environment the user will be using must be tracked and recorded. There are several ways to do tracking for VR but have many similarities. The most commonly used is optical tracking devices. They use light to measure a user's position and orientation. The signal emitter in an optical device typically consists of a set of infrared LEDs. The sensors are cameras that can sense the emitted infrared light. The LEDs light up in sequential pulses. The cameras record the pulsed signals and send information to the system's processing unit. The unit can then process the data to determine the position and orientation of the target. This gives users 6 degrees of freedom (6DoF) allowing them to move around in the virtual world. The most important part of virtual reality, making the user feel like they're still in reality. This is how Virtual reality works.

How to use VR

Setting up VR seems a bit complicated but is actually very easy to do. With modern VR systems, having a headset and controllers won't be enough; you'll need a PC console or mobile device to connect it too. Before you set it up having a small space dedicated to using it is a must to ensure safety and easy mobility while using VR. It'll prompt the user to set the boundaries of where it can be used.

Controls

The controls of VR vary depending on what you're using it for. A Pilot training simulator would have controls quite like a real cockpit to allow them to become better pilots. The controls are built around the needs of a targeted user. Most modern VR consoles come with two hand controllers that have buttons and triggers for all sorts of uses depending on the application. They can act as paint brushes in tilt brush (*Google 2016*) in which the user can take advantage of 6 degrees of freedom to create whatever they want. To look around their environment the user would do the same they would in real life, by moving their head in whichever direction they wanted to look at.

Games

Games have always strived to be more and more realistic, which is why VR is often only talked about in terms of gaming capabilities. Since the early 2010s VR systems have been developed more and more for gaming. Many gaming and tech companies like Sony, Valve, and Samsung have released their own VR setup throughout the last decade to competes. The catalogue of games available in VR at first was quite small, over time game developers began porting already existing highly successful games over to VR such as Minecraft (*Notch 2009*) and Skyrim (*Bethesda 2011*). It's only quite recent that Big gaming studios have started developing games specifically for VR such as the well-received Half-life Alyx. VR is the next step in gaming as it allows for more immersion and possibilities. There are more opportunities for creation in tilt brush (*Google 2016*). By making the gaming experience more

immersive threats and terror in horror games will feel more real and intense such as the popular *Alien Isolation*.

Applications of VR

There are a myriad of applications and uses for virtual reality. It is most commonly used in everyday life for entertainment but can also be used for educational purposes, medical procedures, manufacturing etc. Virtual reality is already used for work related activities in training personnel with equipment where “initial training in a virtual environment can avoid the expense, danger, and problems of monitoring and control associated with training” (*Weiss 1998*) For example it is used in pilot simulation, helps with problems with radioactive waste removal, astronaut training etc. Virtual reality has a huge potential in aiding education. First-hand experiences account for most of our activity and learning of the world (*William Winn 1993*). Students will no longer be observers to information but active participants in constructing it themselves. Those studying history will be able to see, feel and hear important events throughout time, engaging them more in the subject than they would’ve been before. Surgeons today are using VR to allow them to visualise problems with intricate organs like hearts and brains to spot problems before the surgery takes place. VR has also shown potential to be used for rehabilitation. The advantage of using it over conventional therapy for physical therapy is that it’s not as repetitive preventing boredom and keeping the user engaged. It can be used in the patient’s home and without a health care professional reducing cost and giving freedom to the patient being able to use it wherever and whenever they’d like.

Pros and Cons of VR

Question of Pros vs Cons

Virtual reality (VR), like any technology, has its positives and negatives. We will look at how its physical safety may be offset by the psychological damage. Should people take advantage of the versatile nature it offers? How immersive is it truly? What are the pros and cons of this compact piece of technology?

Positives of Virtual Reality

One of the major advantages of virtual reality (VR) is that it requires very little space to use. Needing only enough room for somebody to freely move their arms around in a full 360° rotation around their body, VR can be accommodated into most people's houses with relative ease. Compared to augmented reality, which needs large open spaces in order to function, VR is compact and convenient.

As VR can be used in a relatively small space, it is also far safer than augmented reality. Where augmented reality can distract the user from dangers in front of them, VR is done indoors. This means that users can use VR in a safe and controlled environment, be it in their own home or in a simulation rig. This is similar to a console or PC video game, where the user is sat down or stationary whilst using this device, they are in no risk of injuring themselves or those around them. VR is much the same in this regard.

One of the strongest attributes of VR is its immersive capabilities. Reviews of VR headsets, from companies like Sony and Oculus, have identified the immersion as a unique selling point. Through sounds and the intricate way in which they are designed, VR is said to make the experiences of playing a video game or watching a film far more exhilarating.

Though video calls are available from platforms, such as Zoom or Skype, it is considered that VR offers a subjectively better interaction system. When people are interacting with each other in VR, they are interacting in a 3D environment. This enables them to feel more in touch with what is going on around them. They can also hold meetings, conferences, get-togethers and even interact through a video game in a way that feels more involved than if they were just using Skype or Zoom.

The ability to change your environment in VR is seemingly endless. Users can go between touring countries of the world and significant landmarks to being in a conference room. This diversity makes VR feel more varied and opens up more opportunities for interactivity than video games, due to the differences in immersion.

VR is most often associated with video games through both consoles and PC, however, to say that this is the only application of the technology is far from the truth. VR can be applied to multiple fields of practice including, but not limited to, medicine, military practice and education. Not only does this provide a safe and adaptable environment for people to train in, it also offers a more immersive training experience than they may otherwise receive.

Negatives of Virtual Reality

Though VR is well regarded for its immersive atmosphere, the mobility aspect is limited. VR technology has allowed users to have great upper body interactions with the world, through their arms and head. However, advancement in the lower body hasn't progressed nearly as far. Whilst the reasons for a lack of leg movement is obvious, to do so requires specialised rigs and harnesses, it is criticised as detracting from the user's experience. Though many VR simulators have attempted to

get around this issue, usually by using their hands to grapple onto ropes or other structures, it is rarely done successfully in a way that the immersion is kept intact.

The headgear and other controls used in VR are relatively small for what they are. That isn't to say that they are not without fault. One problem that recurs consistently is the band holding the headgear in place. There has been numerous complaints of it starting to hurt after prolonged use. Though this can vary from model to model, and is certainly more prominent in others, it still appears as an apparent issue. Then there is a question of weight. Small they may be, the headgear and controls are still bulky. Weight is a common issue that increases the strain on the headband, tiring the user out more. Though there have been attempts to counteract this drawback, it remains a problem to this day.

The issue of addiction has long been a problem associated with VR. It has generated many studies and also many pieces of fiction, such as Ready Player One, which tackles this specific issue. There are debates that VR could detach humans from the real world in an unhealthy way. Furthermore, there are growing concerns that VR could be more dangerously addictive than other forms of social media. Whilst it does keep the user active, it may lead to serious mental problems and that prolonged usage may lead to the brain's inability to distinguish between reality and VR.

Whilst VR does offer a safe environment, it is well documented that it does affect brain activity. Motion sickness is a common problem people have with VR headsets. This also includes feelings of dizziness and nausea. When the software lags or is slow to respond is when these symptoms appear most frequently. Alongside that, a study into how the hippocampus section of the brain interacts with VR was done by the University of California. In the study, they ran a test on some lab rats and found that the hippocampus would behave erratically when in VR even though the rats displayed no signs of agitation or discomfort. This has brought up concern on whether VR could damage this part of the brain without users realising it.

VR is highly praised for its immersion and versatility in its ability to train individuals to perform specific duties such as practices in medicine and combat. However, there are questions over how truly effective it is as a training tool. Immersive it may be, but there are people who believe that the immersion created by VR isn't truly reflective as to how a situation would play out in real life. This is mainly contributed to the fact that whilst VR can offer a sense of sound and sight, it doesn't offer the experience of the other three senses. What's more, the lack of true depth of view also means that it can't offer the truest experience.

Sum up of Pros vs Cons

What we have seen is that virtual reality (VR) is compact and convenient. We also saw that VR can be used in a safe and controlled environment, with no risk to the user or those around them. VR was seen to make experiences more exhilarating, in a way that feels more involved than if they were just using Skype or Zoom, with a seemingly unlimited environment. We saw how virtual reality can be applied to so much more than just video games. Despite these positives, we found some drawbacks that come with VR. With the lack of advancement in the lower body movement and pain generated by the headband can have a negative impact on the immersion. VR is not a flawless system. It is more addictive than people may realise and could harm our mental wellbeing. The existence of negatives in VR isn't a surprise, as all technologies have some drawback. We can only look to the future to see how these positives and negatives change.

Future of Virtual Reality (VR)

But what is the future of VR? It's challenging to predict the types of technology we will have 10 years from now. We believe it is likely that VR technology will be a much bigger part of our world. The corona virus outbreak proved that our society can still function using the internet, we believe as the years go on, we will improve on this, creating more advanced technology for virtual interactions. VR still has a long way to go before it is totally undistinguishable from reality, companies such as Pimax have developed 8k headsets, which provides a more captivating experience, but requires a very powerful processor.

Also, with the development of 5g, future users of VR could potentially receive images in real time, just like if they were viewing the real world. Currently movement in VR is somewhat difficult, products like KAT VR which allows a user to have complete control over there lower body actions, such as walking, and running have created a new more immersive experience for users. VR treadmills have also been developed, allowing the player to move on the spot. Unfortunately, these products don't work very well right now. They are also quite expensive.

Overtime It is likely that improvements will be made to these devices. Developments in hepatic feedback are also being made, right now haptic gloves such as VRgluv are big, clunky and not easily accessible for consumers. The dream would be to have haptic gloves that look and feel like any normal glove but at the same time provide an effective touch simulation. In order to really immerse the user in a virtual world, full body haptic suits will have to be used.

Companies such as TeslaSuit have created working suits, but again they are not easily available to the consumers, right now they are being used for tasks in dangerous environments such as astronaut training. As we travel into the future VR headsets will also have to be improved upon, right now they are large, heavy and can cause irritation and discomfort after long periods of using them. Eventually it is hoped that VR headsets will be light and easy to ignore when wearing them.

VR can also be a huge part of the workplace of the future, right now more and more people are beginning to work from home, meetings are being held on platforms such as skype, the problem with this is a large amount of body language is lost. The next step in online meetings is VR, this allows for more efficient communication. Finally, one can only hope we avoid the dystopian future detailed in the 2018 movie Ready Player One where humanity lives in a virtual world in order to escape the bleakness of our own world.

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