Technology in Virtual Reality

Sierra McCarthy

March 26, 2024

CSIT 100

Have you ever wondered how such a simple device can instantly transport us into a new world? What components does virtual reality need to be fully immersive? With new concepts emerging, VR becomes more complex and sophisticated every year. Today, VR is a multi-million-dollar industry that is rapidly changing the way we interact with technology. In this essay, I will take you through the evolution of VR and why it's such a significant tech evolution.

What is virtual reality, you may wonder. VR creates environments, experiences, and interactions that look and seem real but aren't. VR is a combination of software and hardware, which replaces our natural world with generated alternatives. By wearing a VR headset, users are transported to an interactive world in which it can be explored and manipulated. This could make the user feel immersed in their surroundings. To ensure that the experience is immersive, the system consists of infrared LEDs, motion sensors, screens, and cameras. VR sets are programmed to trick our natural stimuli and our responses. This allows the system to create virtual objects that trick the human brain. Simply, virtual reality goes off the basis of what we hear and see that shapes our everyday world. On a broad level, all forms of VR attempt to immerse the user in these experiences. However, there are various forms of virtual reality.

When people think of VR, they typically think of fully immersive experiences, but that's not always true. There are different levels of immersion, such as non-immersive, semi-immersive, and fully-immersive. Starting with the term non-immersive, this is deemed an inaccurate title because all VR experiences have some immersion. However, this VR type only lets you interact with the virtual surroundings on a fundamental level. There are no spatial computing features. Instead, you use controllers to interact. What virtual reality game can be non-immersive if all VR has some immersion in them? A good example is a simulator, such as a driving simulator. All this game requires of the user is to sit behind the wheel and interact with the pedals. This typically does not involve a VR headset, unlike the semi-immersive VR. Semi-immersive is a type of VR that can be described as mixed reality. It is called semi-immersive because it does not create an illusion of a different reality. Instead, you heighten your natural environment by adding digital objects on top of real objects. This form of VR is common in educational environments. For instance, flight engineers can use heads-up displays, also known as HUD, to see digital objects such as windshields or other devices. However, the most frequently used VR is the fully immersive experience, which provides a 360-degree simulated environment. With fully immersive VR, the world around you completely disappears and is replaced with images and sounds. These headsets use AI and motion sensors to move you through this alternate reality. Although only three immersions are associated with VR, many components go into making these devices.

The most significant component of VR is the headset. These head-mounted wearable devices replace your natural field of vision with a computer-generated alternative. With VR headsets, stereoscopic lenses are positioned between a screen and the eyes to distort the image and make it seem three-dimensional. The headset passes two images through each eye. Trackers allow the device to shift between images as the user moves their heads to navigate. Another component within the headset is latency and field view. These elements align the virtual information within the headset with the real world. Generating a 3-D environment convinces the user's mind that they're in a different world. The average human sees the world around them in a 200 to 220-degree arc around their heads. The vision from their left and right eyes overlap at an angle, which causes them to see three dimensions. Minimal latency ensures users see change simultaneously when moving their heads. Similar to latency, the frame rate of a VR device can regulate how immersive the experience can be. The frame rate can also cause VR sickness if not created properly. The human eye can see up to 1,000 frames per second, while the brain only interprets frame rates up to 150 FPS. VR creators found that if the rate is less than 60 FPS, it can cause nausea and headaches. So many developers aim to have 90 FPS to ensure a smooth VR experience. To make VR an immersive experience, they also include spatial audio. This feature has become popular due to its realistic components. For years before VR became so well known, many audio innovators, such as Spotify and YouTube, have used this type of 3D audio. The user can hear sounds from different areas, such as behind, above, or below, which can be determined by where you are in the VR experience. Movement and position tracking go hand in hand with spatial audio in creating this experience. This immersion comes from users' ability to move around and interact with their environment. Position-tracking technologies use a combination of sensors and AI to control what the user sees while moving around. Headsets typically use three degrees of freedom systems, which allow users to move their heads. Virtual reality software is a combination of 3-D environments with tons of different components that make the experience interactive and immersive. Headsets typically come with a controller. Although VR developers have been experimenting with spatial technology like trackers or sensors to minimize the use of controllers, many headsets still have connective controllers. These controllers are hardware with buttons, thumbsticks, and sensors that track user hand movements, which translate to actions in the virtual world. VR software can be versatile and can fit any user's needs. Nevertheless, the VR we know today wasn't always like this.VR headsets seem like an entirely new concept. However, virtual reality has been around for decades.

This concept first came to light when science fiction writer Stanley Weinbaum created a fictional model of VR in his short story called "Pygmalion Spectacles" in 1935. In this story, the main character meets a professor who invented a pair of goggles. As stated in Pygmalion Spectacles, "a movie that gives one sight and sound, taste, smell, and touch.". This concept shows how this character is immersed in this story. With this idea in mind, many people have tried to make this story come to life by creating this alternate reality. However, it wasn't until 1962, Cinematographer Morton Heilig created "Sensorama", the world's first VR experience. This machine was a booth-like structure that could fit up to four people at a time. This machine was combined with multiple technologies to explore all of our senses. This machine consisted of a color 3D video, vibrations, smells, and even gusts of wind, giving the experience an atmospheric effect. They created this unique experience using a vibrating chair, scent producers, and a stereoscopic 3D screen. This inventor's goal was to immerse people fully in their films.

Although these are exciting concepts, VR in the 21st century is most famously known for being a headset, not a machine. In 1960, Morton Heilig invented yet another spectacular VR experience, which led to the creation of our VR headsets. This invention was called the "Telesphere Mask," which was mounted on a person's head. There was no sensory tracking; it was just 3D images with wide vision. But that wasn't until the following year corporation engineers Comeau and Bryan took it into their own hands, inventing "Headsight." Headsight was the first motion-tracking HMD. Each eye had its built-in video screen and a head tracking system. These inventors had great ideas and concepts, but not one had an interactive experience that replicated reality. Until Ivan Sutherland, a computer scientist, wanted to achieve a false reality.

Sutherland states, "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." This statement was exclaimed in his article called "The Ultimate Display." Sutherland's releasing this article deemed him the fundamental blueprint of virtual reality. Sutherland and his student, Bob Sproull, created the first virtual reality HMD called "Sword of Damocles." This head-mounted device was connected to the computer and was underdeveloped since it only showed virtual wire-framed shapes. This device had a motion tracker that made the user develop a perspective. This technology was suspended from the ceiling and was quite heavy, so it wasn't developed further. Following this invention, an inventor named Kruegur created the first "Videoplace" in 1975, the first interactive virtual reality platform. It comprised projectors, video cameras, computer graphics, and position-sensing technology. Unlike the other VR devices invented, this one didn't require goggles or gloves. "Videoplace" was a dark room with a video screen surrounding the user. The user would then see their silhouettes imitating their movements. This was done by recording the user's movements and transferring them into the silhouettes. Users in different rooms were able to interact with other users' silhouettes. This encouraged the idea that people could interact with one another without physically being there. In 1982, Sayre gloves were introduced by Sandin and Defanti. These gloves were the first wired gloves that monitored hand movements. This was done by light emitters and photocells in the glove's fingers. When the user moved their fingers, the light hitting the photocells varied and converted into electrical signals. These listed inventions never sold their products to the public until 1985, when Jaron Lanier and Thomas Zimmerman created the first company, VPL Research, Inc., to sell VR goggles and gloves. They developed various VR equipment such as EyePhone HMB, DataGlove, and the Audio Sphere. Although they had multiple products, this company filed for bankruptcy in 1990 due to them not selling enough of their products to the public. Building upon previous research, many experts would use virtual reality not only for fun but also for the military and NASA education. Furthermore, in 1991, Antonio Medina, a NASA scientist, designed a virtual reality system to drive the Mars robot rovers from Earth. This program would immerse you in your surroundings and educate you on how the rover was made and what Mars looks like. The military would do something similar by having people go through a simulation. This was an excellent way to train the military in flying planes or driving military vehicles.

Virtual reality's rich history paved the way for the most recognizable headset we know today, the Oculus Rift Headset. In 2010, Palmer Luckey created the prototype of the Oculus Rift headset. It featured a 90-degree field of vision, which had never been seen before. This technology relied on computer processing power to deliver images. In 2012, there was a campaign for the Oculus Rift, which raised 2.4 billion dollars. This new development boosted people's ultimate interest in VR. In 2014, Facebook bought Oculus VR company for 2 billion dollars. This was a segue for many other well-known companies to explore the possibilities of virtual reality, which led to tons of 2014 releases, such as Sony, which announced that they were working on "Project Morpheus," a VR headset for the PS4. Then Google released "The Cardboard," a low-cost stereoscopic smartphone viewer. Then Samsung announced the "Samsung Gear VR," a headset that uses Samsung Galaxy smartphones as a viewer. Forbes, a founder of "REWIND," an immersive technology company, describes this as "The year virtual reality gets real." The shift from tethered to a standalone VR experience has shifted how technology will develop in the coming years.

By 2016, hundreds of companies created VR products with dynamic binaural audio. However, at this time, Haptic interfaces were underdeveloped. Haptic interfaces are systems that allow users to interact with the computer using their movement. Therefore, headsets were typically button-operated. HTC released its HTC VIVE StreamVR headset, the first commercial release that included Sensor-based tracking headsets. In 2020, The Oculus Quest 2 was released. Compared to the Oculus 1, this has a much-improved chipset and works with the snapdragon XR2 system, which allows for better and more comprehensive games. This was a significant improvement over the old system of the Oculus 1. The following year, Pico launched the Pico Neo 3 headset, a competitor to the Oculus Quest 2 headset.

However, Facebook, also known as Meta, plans to spend at least $10 billion in 2021 on Facebook reality labs, according to Mark Zuckerberg, which creates AR and VR hardware, software, and content. On June 5, Apple released The Vision Pro, a mixed-reality headset. This device captures data from the user's natural surroundings and is processed through a 3D map, known as spatial mapping. This device inserts digital objects into the user's reality, which is why the term mixed reality kicks in. This is because the user's actual surroundings are layered by virtual reality. This headset sells for $3,499. On June 1, a few days later, Meta announced Meta Quest 3, which was released on October 10. This headset features significant adjustments in display and quality, such as a boost in the resolution of 2160 x 2160 per eye compared to other VR sets. This device uses virtual and mixed reality to enable features like hand tracking, video conferencing, keyboard tracking, and remote desktop streaming.

Currently, in 2024, Apple Vision Pro was released on February 2 to early adopters in the U.S. The release caused some excitement, while some raised concerns about the accessibility and content ecosystem. Nonetheless, this headset is capable of running Apple apps, including books, contacts, mail, Facetime, camera, and many more, with a blend of both AR and VR. Users can pull a 3D object out of an app and expand fully into their space.

However, as companies continue developing VR advancements, the answer to "how virtual reality works" might change. Exploring the complexities, virtual reality has significantly progressed and is being used in different ways, from helping immersive gaming to learning a new skill. VR is full of components that take people on virtual journeys. With the rise of smartphone technology, VR can become even more complex than ever.

Works Cited

Barnard, Dom. “History of VR – Timeline of Events and Tech Development – VirtualSpeech.” *VirtualSpeech*, 20 February 2023, https://virtualspeech.com/blog/history-of-vr. Accessed 21 March 2024.

“How does Virtual Reality Work? The Ultimate Guide.” *XR Today*, 18 December 2023, https://www.xrtoday.com/virtual-reality/how-does-virtual-reality-work/. Accessed 21 March 2024.

Sterling, Bruce. “Augmented Reality: "The Ultimate Display" by Ivan Sutherland, 1965.” *WIRED*, 20 September 2009, https://www.wired.com/2009/09/augmented-reality-the-ultimate-display-by-ivan-sutherland-1965/. Accessed 21 March 2024.

“Apple Vision Pro.” *Apple*, https://www.apple.com/apple-vision-pro/. Accessed 23 March 2024.