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Review: Advancement in Virtual Reality Device

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ABSTRACT

In this paper we shed light on the advancement in Virtual Reality devices and talk about six latest developments. Virtual reality (VR) is a technology that allows a user to interact with a simulated computer environment, whether that environment is a simulation of the real world or an imaginary world. It is the key to experiencing, feeling and touching the past, the present and the future. It is the means of creating our own world, our own personalized reality. It could range from creating a videogame to taking a virtual tour of the universe, from walking through our own dream house to experiencing a walk through a strange planet. With virtual reality, we can experience the most intimidating and exhausting situations by playing safely and with a learning perspective. However, very few people really know what virtual reality is, what are its basic principles and its open problems. In this document, a historical description of virtual reality is presented, basic terminology and classes of virtual reality systems are listed. An in-depth study of typical VR systems is done and find the challenges of virtual reality.

KEYWORDS: *Virtual Reality, Sensorma, cyberspace*

I. INTRODUCTION

Virtual reality is considered to have begun in the 1950s, but it caught the attention of the public in the late 1980s and 1990s. This can be attributed to the pioneering computer scientist Jaron Lanier, who introduced the world in 1987 in the term "virtual reality". Research on virtual reality continued in the 90s and that, combined with the appearance of films like The Lawnmower Man, helped to raise its profile. The largest part virtual reality environments are mainly visual experience, which are displayed on a computer screen or through special stereoscopic displays. Virtual reality can also include auditory stimulation through speakers or headphones. Users can interact with the virtual environment through the use of devices such as a keyboard, a mouse or a wired glove. The history of virtual reality has been largely a story of attempts to make a more real experience. Most historical examples are visual and, to a lesser extent, auditory. This is due to all human senses; vision provides by far the most information followed by hearing. Probably 90 percent of our perception of the world is visual or auditory.

II. EVOLUTION OF VIRTUAL REALITY

The first idea was presented by Ivan Sutherland in 1965: "make that (virtual) world in the window look

real,sound real, feel real and respond realistically to the actions of the viewer "[Suth65][1] It's been a long time since then, a lot of research has been done, let's look briefly its highlights from last three decades:

Sensorama: the Sensorama machine was invented in 1957 and was patented in 1962 under patent n. 3,050,870. Morton Heilig produced a multisensory simulator. A pre-recorded stereo and color film be augmented via binaural sound, aroma, wind and vibration experience(Jozef Novak-Marcincin). The first approach was to create a virtual reality system and of that environment it had all the characteristics, but it was not interactive.

Fig 1. Sensorama Machine

The definitive screen: Ivan Sutherland proposed the definitive solution of virtual reality in 1965: a concept of artificial construction of world that incorporated interactive graphics, sound, smell, taste and forced feedback,."The sword of Damocles": the first virtual reality system which was made in hardware not in a concept. Ivan Sutherland builds a device considered to be the first head-mounted display (HMD), with sufficient tracking of the head. It supports a stereo view that was updated correctly according to the orientation and position of the user's head.

Fig 3. Head Mounted Display Machine

GROPE: the first prototype of a force feedback system conducted at the University of North Carolina (UNC) in 1971. **VIDEOPLACE:** Artificial reality created in 1975 by Myron Krueger: "a conceptual environment, without existence". VIDEOPLACE was created where the computer had control over the relationship between the participant's image and the objects in the graphic scene. It could coordinate the movement of a graphic object with the actions of the participant. **VCASS:** In 1982 Thomas Furness of the Armstrong Medical Research Laboratory of the US Air Force developed the Simulator of Aerial Systems Visually Coupled, an advanced flight simulator. The fighter pilot wore an HMD that increased the view from the window by the graphics that describe the orientation or the optimal information of the flight route. **LIVED:** Visual visual visual environment screen: built in Ames NASA in 1984 with standard tools and a stereoscopic monochromatic HMD. **VPL:** The company VPL manufactures the popular DataGlove (1985) and the Eyephone HMD (1988), the first commercially available virtual reality devices. **Walkthrough Project UNC:** In 1980s at the University of North Carolina, an architectural tour application was developed. To improve the quality of this system several virtual reality devices were built, such as HMD, optical trackers and the Pixel-Plane graphics engine. **Virtual Wind Tunnel-** is developed 1990s in the NASA Ames application that allowed the observation and investigation with the help of BOOM and DataGlove.

BOOM(Binocular-Omni-Orientation monitor)- In 1989 BOOM is marketed by Fake Space Labs, it is a small box which contains two cathode ray tur CRTs monitors that can be seen through consumers The consumer can grab the box, keep it in view and move around the virtual world, since the auto mechanical arm measures the box position and orientation.

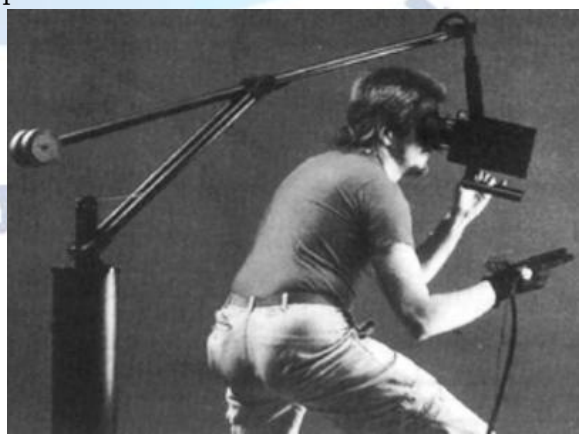

Fig 3. Binocular-Omni-Orientation monitor Machine

CAVE (Automatic Virtual Environment) **–** CAVE is

presented in 1992. Instead of using an HMD, it projects stereoscopic images onto the walls of the room (the consumer must have to wear LCD shutter glasses). This move toward and ensures the superior quality and resolution of visualized images and a wider field of view compared to HMD-based systems.

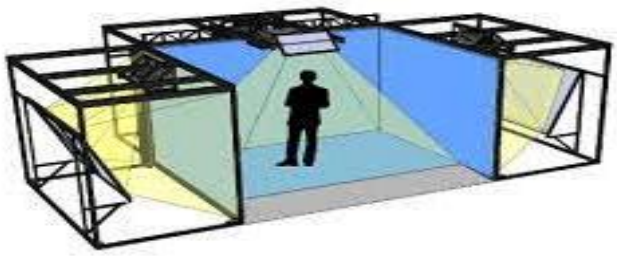

Fig 4. CAVE Automatic Virtual Environment Machine

III. WHAT IS VIRTUAL REALITY? SOME BASIC DEFINITIONS AND TERMS USED

The virtual reality became much stormier in 1990s and we can hear about Virtual Reality in almost all sorts of media, also people use this term very often and they use wrongly it in many cases too[2-7].

- Virtual Reality (VR) is popular name for an interactive, mediated Computer experience in which person perceives a simulated environment by means of human-computer interface Equipment. It interacts with simulated things in that environment as if they were real. Several people can see one another and interact in shared virtual environment such as battlefield.
- Virtual Reality is a term used to describe a computer generated virtual Environment that may possibly be moved through and manipulated by a consumer in real time. A virtual environment may be displayed on a head-mounted display, a computer monitor, or a large projection screen. Head and hand tracking systems are in use to make possible the consumer to observe, move around, and manipulate the virtual environment.
- The main difference between VR systems and traditional media (such as radio, television) lies in three dimensionality of Virtual Reality structure. Immersion, presence and interactivity are peculiar features of Virtual reality that draw it away from other representational technologies. Virtual reality does not imitate real reality, nor does it have a representational function. Human being's have inability to distinguish between perception, hallucination, and illusions.
- VR has grown into a new phase and becomes a distinct field in world of computing. The utility of VR has already been researched in car design, robot design, medicine, chemistry, biology, education, as well as in building design and construction (Whyte, j. et al., 1999).
- There are some differences between these definations but they are equally same. All are having a same meaning that VR is a very interactive and immersive experience in a simulated world [Zelt92]. Many people, mainly the researchers use the term Virtual Environments instead of Virtual Reality "because of the hype and the associated unrealistic expectations" [Giga93a]. Moreover, there are two important terms that must be mentioned when talking about VR: Telepresence and Cyberspace. They are both tightly coupled with VR, but have a slightly different context:

Basic Terms

- **Telepresence** and **Cyberspace** – The term was coined by Marvin Minsky (1980) in reference to teleoperation systems for remote manipulation of physical objects. It is a specific kind of virtual reality that simulates a real but remote (in terms of distance or scale) environment. Another more precise definition says that telepresence occurs when "at the work site, the manipulators have the dexterity to allow the operator to perform normal human functions; at the control station, the operator receives sufficient quantity and quality of sensory feedback to provide a feeling of actual presence at the worksite" [Held92]. **Cyberspace** was invented and defined by William Gibson as "a consensual hallucination experienced daily by billions of legitimate operators (…) a graphics representation of data abstracted from the banks of every computer in human system" [Gibs83]. Today the term Cyberspace is rather associated with entertainment systems and World Wide Web (Internet).
- **Telexistence –** This concept was first proposed by Susumu Tachiin Japan in 1980 and 1981 as patents and the first report was published in Japanese in 1982 and in English in 1984. It enables a humanbeing to have a real-time sensation of being at a place other than where he or she actually exists, and being able to interact with the remote environment, which may be real, virtual, or a combination of both. It also refers to an advanced type of teleoperation system that enables an operator at the control to perform remote tasks dexterously with the feeling of existing in a surrogate robotworking in a remote environment.

- **HCI (Human-Computer Interaction) –** refers to the study and process by which humans interact with computers. Very basic HCI is something as simple as a keyboard and mouse while advanced HCI could be thought-controlled interactions between a person and a computer.
- **Haptics and Haptics technologies–** The word "haptics" refers to the capability to sense a natural or synthetic mechanical environment through touch. Haptics also includes kinesthesia, the ability to perceive one's body position, movement and weight. **Haptics technologies –** provide force feedback to users about the physical properties and movements of virtual objects represented by a computer. A haptic joystick, for example, offers dynamic resistance to the user based on the actions of a video game. Haptics incorporates both touch (tactile) and motion (kinesthetic) elements. For applications that simulate real physical properties—such as weight, momentum, friction, texture, or resistance—haptics communicates those properties through interfaces that let users "feel" what is happening on the screen

IV. TYPES OF VR SYSTEMS BASED ON THE LEVEL OF IMMERSITY

In the system of a virtual environment, computers generate sensory impressions that are delivering to the human senses. The form and feature of these impressions decide the level of immersion and the sensation of existence in virtual reality. In an ideal world, high resolution, quality and consistency on all screens, the information should be presented to all the user's senses. In addition, the environment itself must react realistically to the user's actions. The practice, however, is very different from this ideal case. Various applications stimulate only one or some of the senses, very often with low down quality information and not synchronized. We can group VR systems according to the level of immersion they offer to the user.

1. **Immersive systems:** the definitive version of virtual reality systems. They allow the user to fully immerse themselves in the computer-generated world with the help of HMD that supports a stereoscopic view of the scene according to the position and orientation of the user. These systems can be improved by audio, haptic and sensory interfaces. According to Ernest Adams, immersion can be sub-divided into three main categories:

- **Tactical immersion:** tactical immersion is experienced when tactile operations involving skill are performed. Players feel "in the zone" while perfecting the actions that result in success.
- **Strategic immersion:** strategic immersion is more cerebral and is associated with a mental challenge. Chess players experience a strategic immersion by choosing the right solution from a wide range of possibilities.
- **Narrative immersion:** narrative immersion occurs when players engage in a story, and is similar to what is experienced when reading a book or watching a movie. Staffan Björk and Jussi Holopainen, in Patterns In Game Design, divide the immersion into similar categories. They call them sensory-motor immersion, cognitive immersion and emotional immersion, respectively. In addition to these, they add three new categories:

Spatial immersion: spatial immersion occurs when a player feels that the simulated world is convincing from the point of view of perception. The player feels that he or she is really "there" and that a simulated world looks and feels "real". **Psychological immersion:** psychological immersion occurs when a player confuses the game with real life. **Sensory immersion:** the player experiences a unit of time and space when the player merges with the middle of the image, which affects the impression and perception.

2. **Non-immersive systems (desktop VR):** desktop virtual reality is a lower level of immersive virtual reality that can be easily used in many applications without the need for special devices. Desktop VR is when a computer user sees a virtual environment through one or more computer screens. A user can then interact with that environment, but is not immersed in it. Use a conventional monitor to display the (usually monoscopic) image of the world. No other sensory output is compatible. Virtual desktop reality has begun to break through and its popularity in modern education due to its ability to provide real-time visualization and interaction within a virtual world that closely resembles a real world.
3. **Semi-immersive systems (Fish Tank VR):** improved version of Desktop VR. These systems are compatible with the tracking of the head and, therefore, improve the feeling of "being there" thanks to the parallax effect of movement. They continue to use a conventional monitor (very often with LCD shutter glasses for stereoscopic viewing) but in general they are not compatible with the sensory output.

It is not easy to define all the uses of virtual reality because now it is enough to develop in many fields. Here, some uses of virtual reality are

explained.EDS Jack is an example of a commercially available virtual reality software package. It is mainly used for visibility and ergonomics studies. These are two of the areas in which virtual reality really benefits. For example, when designing a large mechanical device such as an excavator or even a car, visibility and ergonomics are very important for operators. Would you buy a car that was uncomfortable to drive or had poor visibility, probably not? Many companies spend a large amount of money on making their products interact better with operators. The cost of building prototypes is very expensive, more than a few million dollars for a machine using the example of a bulldozer. Through the use of virtual reality, the company can check the viability and ergonomics of your machine quickly and make changes without spending money to build hardware. Another area in which virtual reality is widely used is flight driving or simulation. These give users the opportunity to gain experience operating a vehicle without the real consequences of making a mistake. MPI Vega Prime is an example of a software package that supports any type of driving simulation. The user constructs the virtual environment within the software package. Its biggest advantage is its realistic physics engine that supports collision detection. Flight simulators are the most common type of machine simulation. Some other examples would be the use of simulators by the United States Army to train tank solders with virtual tank wars. NASA also trains its astronauts on how to land the space shuttle with a virtual reality simulator.

V. ADVANCEMENTS IN VIRTUAL REALITY DEVICES

Although it may seem futuristic, the concept of virtual reality has actually been around for a long time. Virtual reality continued to be popular throughout the 1990's but eventually the public lost interest due to a lack of novel applications and advancements for the technology. Over the past few years, a new wave of interest in virtual reality (VR) has formed. It started with the design of the first prototype of the Oculus Rift in 2010 followed by next-gen video game developer Valve's introduction of low-persistence displays in 2013. This technology offered a lag-free experience and smear-free display for consuming VR content. Today's technology has pushed VR even further, and researchers continue to make environments more and more lifelike. One crucial component to making a VR experience more realistic, is low persistence OLED, which has become the technology of choice for viewing devices that help users with "maintaining presence in VR." Other important factors associated with this viewing experience include tracking, low latency, high resolution, and high quality optics.A new report from market research firm[8] highlights the innovations underway that are moving the field toward even more realistic visuals and better user experiences.

Visualization advancements: Currently, most VR experiences occur via various head mounted displays. Companies like Avegant and Magic Leap are pursuing two potential breakthroughs that could enhance usability. One, called **focus tunable displ**ays, entails projecting virtual content in multiple focal planes, improving the user experience by tackling issues of visual discomfort. **Lightfield cameras** will be crucial to this process. This type of technology—which is currently being made by companies like Lytro— can re-focus pictures even after they have been taken, by harnessing a microlens array and special light field sensor to analyze which direction rays of light are entering the camera. This permits a multidimensional light field to be recorded, which then is passed through special software. Algorithms synthesize the data to simulate what the image would look like if it was focused on a different plane or captured from a different angle. Another approach is **foveated image rendering**, which could yield performance optimization. A key tenet of this strategy is that it relies on the incorporation of eye tracking technology built into the headset. Essentially, this involves reducing the image quality in the wearer's peripheral vision, since the maximum resolution is expected only at the fixation point of the eye's retina, called the fovea.

Functionality breakthroughs

To improve functionality, engineers need to tackle several development challenges present in the current generation of headsets. Currently, tethering is still necessary, and display and optics are still below human limits. The weight and ergonomics of the VR device itself also still need improvement. Mastering these issues, as well as refining advancements in visualization and user experience, could lead to new formats for viewing these virtual reality experiences. One unique designs for new VR headsets is incorporating the technology into a helmet. DAQRI, a seven-year-old startup with 350 employees and over $130 million in investment, has created a device that integrates

augmented reality technology in a protective helmet for use in industrial operational environments. Emerson, Siemens, and Hyperloop are some of the companies working with DAQRI that will be trying the Smart Helmet in the field. DAQRI also has a pair of smart glasses that support augmented reality viewing that is under development as well.

The device opts for the approach of tethering the processing power onto what the company calls the "compute pack." This design element simultaneously reduces the bulk and weight of the headset itself. Another project in DAQRI's pipeline is potentially creating head-up displays for car windshields. They acquired a UK based company called Two Trees Photonics in March 2016. This firm specialized in building holographic technology based on research that was performed at Cambridge University, according to Forbes[9]. Displays developed at the university employed laser holographic techniques that provided better color, brightness, and contrast compared to other systems.

Novel prototypes

The **IDTechEx** report highlights other unique designs up and coming in the headset space. This includes a standalone VR headset called the Alcatel Vision. It's a pair of goggles attached to a large back pad by a pair of flexible plastic arms that is powered by a 3,000 mAh battery in the back. This was done in an effort to enhance portability/time between recharging and offers users an even distribution of weight for maximum comfort. Plus, it has a 120 degree field of vision, making it the largest headset available with that view. Another development area that is evolving is the fusion of augmented reality and virtual reality into one all-in-one headset. Intel introduced a headset called Project Alloy at its August 2016 Developer Conference, where the company called it, "an all-in-one virtual reality solution made from the ground up." Intel built this device with its real-sense technology that essentially lets you change the physical environment around you into a digital one, reported Wired[10].

A fully powered computer featuring a Core M processor is at the center of the device, along with vision processors, fish-eye cameras, and a Real Sense 200 series depth sensors. The cameras that will be build into the device will assist in inertial measuring unit with motion tracking. The display will be built with a conventional 1080p-per-eye displays running at 90 frames per second. Sulon q, a Canadian company, is working on a similar product that specializes in the merged reality space. Its augmented reality capabilities will completely replicate the world around the wearer using what the company calls "real-time machine vision technologies."

VI. LATEST DEVELOPMENTS IN VIRTUAL REALITY

The latest developments in virtual reality[11] is given below

Rick and Morty VR Becomes the Most Downloaded PSVR Game in April

Rick and Morty: Virtual Rick-ality became the most downloaded PSVR game in the month of April beating Superhot VR and Job Simulator. The game is developed by Owlchemy Labs and many actors from the original TV series lent their services for the game including Justin Roiland. The game first launched on Steam and Oculus Store and was made available on PSVR on April 10. It took only 20 days to grab the top position for the month.

1001 PPI Display in Works by JDI

Japan Display Inc. (JDI) is a collaborative of Japan's tech giants Sony, Hitachi and Toshiba which revealed in May that the company is developing a 3 1/4" LCD featuring 1001 PPI, especially for Virtual Reality headsets. The company also said in its press release that the display will be ready to ship by the end of the first quarter in 2019 and the company will push innovation to develop even higher pixel-dense displays for VR.

Google Chrome is About to Debut on Daydream Headsets

At Google's Developer Conference I/O 2018, the company unveiled WebXR which is the evolution of WebVR. The technology will allow bringing Augmented and Virtual Reality experiences through the web browser. It was also revealed that company is launching a variant of Google Chrome for Daydream headsets which will let VR users initiate VR apps from inside the headset.

Create VR Tours with Google's Tour Creator

Virtual Reality tours are becoming more and more popular as we move ahead into the future of alternate realities. Google has launched a web tool called Tour Creator that will allow VR enthusiasts and newbie users to easily create VR tours using their own 360-degree photos and Google Street View imagery. The app has an intuitive interface with a user-friendly UX that allows you to drag and drop elements to stitch a VR tour.

RED Digital Cinema is Developing Facebook's VR Camera

Social media giant Facebook entered a deal with RED Digital Cinema with the objective to create a virtual reality camera using Facebook's proprietary Surround360 technology which renders and captures 3D 360 degree content including photos and videos. The announcement came during Facebook's F8 Conference. It should be noted that it was at the last year's F8 when Facebook unveiled spherical cameras featuring Surround360 technology designed to shoot photos and videos volumetrically (3D) in 360 degrees.

Paint in 3D with CoolPaintrVR Creation Tool

CoolPaintrVR is a tilt brush creation tool for creatives who are onPlayStation VR. It is quite similar to Google's own creation tool called Tilt Brush which is an app for artists available on HTC Vive and Oculus Rift. Now PSVR users will also be able to explore the artists within them with the availability of this app.

VII. ADVANTAGES AND DISADVANTAGES OF VIRTUAL REALITY

Virtual reality has additionally been broadly used to treat phobias (including fear of heights, flies and spiders) and put up-worrying strain disease. This kind of remedy has validated to be effective within the instructional environment, and numerous business entities now provide it to sufferers. Although it was discovered that using standardized sufferers for such education was greater sensible, pc-primarily based simulations offered a number of advantages over live education. Its goal became to growth exposure to practical emergency conditions to enhance decision-making and overall performance and decrease psychological misery in a true fitness emergency. Some psychologist's worry that immersion in virtual environments may psychologically affect a user. They suggest that VE systems that place a user in violent situations, particularly as a perpetuator of violence, could cause the user to become desensitized. Indeed, there is a fear that VE entertainment systems could generate a generation of sociopaths. Attracting virtual environments could potentially be more addictive. Another emerging concern involves criminal acts. In the virtual world, defining acts such as murder or other crimes has been problematic. At what point can the authorities charge a person with a real crime for actions within a virtual environment? Studies indicate that people can have real physical and emotional reactions to stimuli in a virtual environment, so it is quite possible that a victim of a virtual attack may feel real emotional trauma.

VIII. CHALLENGES

The big challenges in the field of virtual reality are to develop better tracking systems, find more natural ways to allow users to interact in a virtual environment and decrease the time it takes to build virtual spaces. While there are some tracking system companies that have existed since the early days of virtual reality. Similarly, there are not many companies that are working on input devices specifically for virtual reality applications. Most VR developers have to trust and adapt the technology originally designed for another discipline, and they have to wait for the company that produces the technology to stay in business. As for the creation of virtual worlds, it can take a long time to create a convincing virtual environment: the more realistic the environment, the longer it will take to do so. A team of programmers could take more than a year to duplicate a real room with precision in the virtual space.

Another challenge for developers of VE systems is to create a system that avoids bad ergonomics. Many systems are based on hardware that bothers a user or limits their options through physical ties. Without well-designed hardware, a user may have problems with their sense of balance or inertia with a decrease in the sense of telepresence, or may experience cybersecurity, with symptoms that may include disorientation and nausea.

IX. FUTURE WORK

`The future of virtual reality depends on the existence of systems that address the problems of "large-scale" virtual environments. In the coming years, as more research is done, we are forced to see virtual reality as a pillar in our homes and at work. As computers become faster, they can create more realistic graphic images to better simulate reality. It will be interesting to see how artificial reality improves in the coming years. It is very possible that in the future we are communicating with virtual telephones. Nippon Telephone and Telegraph (NTT) in Japan is developing a system that will allow a person to see a 3D image of the other using VR techniques. The future is virtual reality, and its benefits will remain immeasurable.

X. CONCLUSION

Virtual reality is now involved everywhere. You can not imagine your life without the use of VR technology. In this work we define virtual reality and its history. We also define some important developments that give birth to this new

technology. Now we use the mail or the conference for communication while the person is not sitting with you, but due to technology, distance is not important. This technology offers an enormous scope to explore the world of 3D and your own imagination. It has many applications from product development to entertainment. It is still in the development stage, and many users create their own custom applications and configurations to meet their needs.

REFERENCES

[1] Sutherland, I. E. (1965). "The Ultimate Display". Proceedings of IFIP 65, vol 2, pp. 506–508

[2] [Ande93] R. L. Anderson: A Real Experiment in Virtual Environments: A Virtual Batting Cage. Presence, Vol. 2, No. 1, pp. 16-33 (1993)

[3] [Cruz93a] C. Cruz-Neira: Virtual Reality Overview. SIGGRAPH'93 Course, No. 23, pp. 1.1-1.18 (1993)

[4] [Fuch92] H. Fuchs, G. Bishop et al.: Research Directions in Virtual Environments. NFS Invitational Workshop, Univ. North Carolina (1992).

[5] [Isda93] J. Isdale: What is Virtual Reality? ftp://ftp.u.washington.edu/public/virtual-worlds/papers/whatisvr.txt (1993)

[6] Steur, J. (1995). Defining virtual reality: Dimensions determing telepresence. In F. L. Biocca (Ed.), Communication in the age of virtual reality. Hillsdale, NJ: Lawrence Erlbaum Associates.

[7] Burdea, G. and P. Coffet (2003). Virtual Reality Technology, Second Edition. Wiley-IEEE Press.

[8] https://www.idtechex.com/research/reports/augmented-mixed-and-virtual-reality-2017-2027-technologies-forecasts-players-000535.asp

[9] https://www.forbes.com/sites/aarontilley/2016/03/28

[10] https://www.wired.co.uk/article/test-hands-on-intel-project-alloy

[11] https://www.maxboxvr.com/magazine/latest-developments-in-virtual-reality