CS 591: HUMAN COMPUTER INTERACTION

VIRTUAL REALITY: A HUMAN – MACHINE INTERFACE

Shiv Sankar (B10030), Shoubhik Debnath (B10032)
Indian Institute of Technology Mandi
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INTRODUCTION

What are we doing?
Many people associate virtual reality and computer simulations with science fiction, high-tech industries, and computer games; few associate these technologies with education. But virtual reality and computer simulations have been in use as educational tools too. Although they have mainly been used in applied fields such as aviation and medical imaging, these technologies have begun to edge their way into the primary classroom. There is now a sizeable research base addressing the effectiveness of virtual reality and computer simulations within school curriculum. This paper is an attempt to sample different tastes in Virtual Reality, a discussion of the ongoing trends and a debate on the possible future.

Why is it important?
Computer-based virtual reality has been a common part of modern popular culture and technology for decades now. It is used both as a tool and also for entertainment purposes. The technology has many applications, although its importance may occasionally need some clarification. Following is a small part of the motivation for this report -

- Architectural visualization is one of the applied uses of virtual reality today. A virtual walk-through of a building design, prior to its construction, can actually help architects and their clients better understand what the building will actually be like to inhabit once built.
- The training of pilots for the aviation industry is another popular use of virtual reality today. This is especially beneficial to airline pilots flying simulated commercial jetliners, as it offers the ability to practice something that is relatively risky and costly with an actual plane.
- There is certainly a wide array of possible applications for virtual reality in science. One interesting way virtual reality is already being used is for the design of molecular compounds. Scientists wear a virtual reality control glove which allows them to position molecules in a virtual space.
- Industrial designers can easily manipulate and shape the models they design through the use of a virtual reality display. Some computer graphics cards have outputs specifically for use with stereoscopic headsets for this kind of application.

Our Findings
The history of VR has been recent and sudden. While components have been in development for nearly forty years, working VR systems have only recently appeared on the scene. According to Chesher, "Virtual Reality developed from fiction in 1984 to a rich discourse and a marketed technology by 1992". Although the popular fascination with VR has existed for less than a decade, VR has already gained importance from educational areas to military training, from social interaction to media.

Not only VR offers us a new way to interact with computer but also it enables us to experience a (virtual) world that is impossible in real world.

With its undeniable services at easing human tasks, VR is changing our lives and eventually VR will increasingly become a part of our life.
TEAM STRUCTURE AND RESPONSIBILITY

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DETAIL OF WORK

Methodology

Our literary survey on Virtual Reality began by finding some well-known and good papers on “Virtual Reality”. We achieved this by consulting some sites that rank papers/publications and following various web-blogs. We also browsed through various “Virtual Reality” applications that are interesting and have great future prospect, an example being “Microsoft Kinet”. Once we are done with gathering resources and information, we divided the task of reading through the papers and collecting the main motive out of them. We made notes on the main topics in the field and then we further browsed the internet to get a detailed flavor of the topics as one can see in our document. The document is designed in such a way, so that it explains the theory along with original citing and examples.

Key Findings

Perception and Reality

“Facts as facts do not always create a spirit of reality, because reality is a spirit.” - G. K. Chesterton, On the Classics (1930)

The role of perception in defining reality raises interesting issues of psychological, sociological, philosophical, and cognitive origins. Just how real, for example, are mental constructs or even sensory perceptions? In Heidegger and Virtual Reality: The Implications of Heidegger’s Thinking for Computer Representations, Richard Coyne (1994) addressed the two different approaches that human computer interaction (HCI) and VR researchers have taken to explain perception; the “data-oriented” and the “constructivist views.” According to Coyne, the data-oriented view assumes that the achievement of immersive VR is accomplished by increasing the quantity and quality of data streams to the human sensory organs. Those holding to the constructivist position would argue that immersion can be accomplished with much more limited sensory input, as long as the mind is engaged in the process of “constructing” the reality. Because the reality created by VR is based on the transmission of symbols in an interactive environment, symbolic interactionism may provide a useful schema for its analysis.

According to Brenda Laurel, “Reality has always been too small for the human imagination. We're always trying to transcend” (quoted in McCarthy, 1993). Since the beginning of time people have transcended time and space with little more than their imaginations. Artificial experiences have long relied on the generative ability of the human imagination.
Advances in Meditated Reality
"Reality is 80 million polygons per second" - computer programmer, Alvy Ray Smith

Well before motion pictures there were attempts to recreate reality. Stereographs, precursor to the modern Viewmaster, are pairs of photographs that when viewed using a special device create an illusion of 3-D, and have been described as VR for the 19th century.[1]

While widescreen cinema addressed the visual dimension, others were looking for ways to stimulate additional senses as well. Morton Heilig's "Sensorama" was designed and patented in 1962. Also known as "experience theater" it combined 3-D film, audio, wind and aromas to create a multi-sensory experience in an arcade-like setting.

As we approach the end of the twentieth century it has been determined, by industry and government, that the American public is now ready for Digital High-Definition Television. In development since the late sixties and now finally being introduced to consumers in the United States, DTV promises a new experience for the viewer. With nearly twice the resolution of present television systems, a widescreen format that fills more of the viewer's field of view, and Dolby AC-3 surround sound, the television viewing experience is greatly enhanced. And for those who want an even greater thrill, theme-park attractions feature haptic stimulation, smells, and tastes in addition to enhanced auditory and visual presentations to make the experience "larger than life."

The Technology of VR

“The input and output points of contact define the human-computer interface. If an interface is defined as where two different worlds meet, it would appear that the more dissimilar the two worlds the greater the need for a well-designed interface.” - Unknown

Interface tools used for interactive media include the keyboard, mouse, touch screen, and joystick. For more advanced applications, such as VR, the technology becomes more complicated. The hardware that makes immersive VR, as it is generally understood, possible includes: 1) a head-mounted display (HMD) that presents a wide-angle stereoscopic visual environment, 2) an audio system that provides three-dimensional sound, and, 3) a data glove and/or body-suit and tracking device to gather input data from the user. Other options for input devices include the wand and 3D mouse. At this level, the interface begins to change the nature of user involvement. Sensory data gathered from and provided to the user creates an operating environment that masks the underlying technology.

VR is principally about getting human data into and out of a computer with as little distortion as possible. The most transparent, but still futuristic, approach is the one described by William Gibson in his 1984 novel Neuromancer. In this cyberpunk novel, information cowboys "jack-in to the Matrix" using a wet-wired neural implant to bypass the external sense organs altogether. While this vision seems far from reality, retinal-scanning laser technology that can scan high-resolution images directly onto the optic nerves is currently in development at the HIT Lab in Seattle, Washington.

The HMD, since its first prototype in the 1960s, has continued to evolve.[2] Increasing in resolution and picture quality and decreasing in size and weight, the HMD presents a stereoscopic view of the computer-generated scene that fills the viewers' field-of-view.[3] The display typically includes electromagnetic coils that provide tracking information. This allows the computer to continually update the scene to reflect changes in the position and angle of the user's head.
The development and increased capacity of computer processing technology has made computer-generated imagery possible on a level necessary for true VR. Photorealistic texture-mapped 3-D imagery that responds with minimal lag time to the user's gaze or gestures has been possible for only a short time, and affordable for an even shorter time. The computer chips necessary to perform such feats becomes smaller, more reliable, and less expensive every year. At the same time, 3-D audio systems have advanced to bring the same level of realism to the auditory dimension.

The data glove is an input device that is worn on the hand and that allows the user to gesture, point, motion, or even "pick up" virtual objects. Fiber optic sensors measure the position and flex of the hand and supply this information to the computer. As with all VR hardware, early versions of the devices were costly. VPL Research's DataGlove sold for approximately US $8000 in the early 1990s. Interestingly, Mattel briefly offered a similar glove called the PowerGlove for its NES game system.

Another sense that has been the target of VR research has been that of touch. Haptic interfaces that provide information to the fingertips and other sensitive areas are used to give the user a sense of the tactile qualities of the virtual world. Force feedback systems take this a step further by providing realistic information about the behavior of the virtual device. For example, the joystick used to fly a plane or the steering wheel used to direct a car should transmit information back to the operator for a fully realistic experience. Motion platforms, used both by NASA and by immersive amusement park VR rides, convey a sense of bodily motion with "carefully calibrated movements, vibrations and jolts" (Biocca, 1992b, p. 47).

**VR Applications**

The concept of VR has captured the imaginations of people from a diverse spectrum of modern culture. Diverse cultures ranging from cyberpunk to the military collaborated in bringing VR to life. From this perspective, VR is really about providing an alternative to our mundane, everyday reality. On the other hand, VR applications for business and commercial purposes are promoted for very different purposes. These apparently distinct views of VR, the first as an environment that will allow us to modify our mental or emotional state and the second as an environment that will allow us to manipulate our physical environment, suggest very different uses for VR development.

**Military Applications:** The military origins of VR are evident on numerous fronts. The Defense Department's SIMNET project allows participants to "practice" war by linking simulators around the country, and even around the world (Hapgood, 1997). Learning sophisticated aircraft systems has been at the forefront of military research.

Military uses of VR involve problem solving and experimentation that is more efficient and less costly when performed virtually. Flight training for air combat, missile launches, and other high-risk activities can be practiced in relative safety and at less expense on virtual battlefields. However, simulation is not the only military application of VR technology. C. J. Keep (1993), describing the "Super Cockpit" program of the US Air Force, pointed out an important difference between this technology and the flight simulators that have gone before. "In the hyperreal Super Cockpit, the work performed in the virtual space is also work done in the real world; when the 'young fighter jock' downs a 'bandit' by pushing 'a phantom button on a virtual display screen,' then it is not a virtual person but a real person who dies in the bright light of a real air-to-air missile."
Commercial Applications: Businesses with an interest in VR include architecture (McMillan, 1994), medicine, travel, and science. Taking a virtual tour through a building still in the process of architectural design is just one example of the practical application of VR research. A slightly different proposed application is for the visualization of and navigation through data in three-dimensional space (Leftwich, 1993). Elizabeth Weiss (1996) envisions an application for VR in “The cybergym; Virtual reality in the health club.” In her article, Weiss envisions a time when one will be able to, “cross-country ski across a mountain, row across a lake, or even bike across America. But gone are any unpleasant snow moguls, the irregular currents of a lake, or those unpredictable hills in nature”.

Such utopian visions of a future where family time and togetherness are facilitated by VR technology appear to me to run counter to the lessons of history and ignores the reality of human nature.

Virtual Sets: Another commercial application of VR technology is not one you'll find on your desktop computer, but rather one that may become increasingly visible on your television receiver. “Virtual set” technology makes possible computer generated sets that replace the conventional sets found in the typical television studio. Instead of sets manufactured from wood and paneling, virtual sets are computer generated. When combined with live-action elements, such as actors and props, they allow a studio production to appear as though it is taking place in any real or imaginary location of the producer's choosing. The “virtual” nature of the technology, and what sets it apart from more traditional blue-screen or chroma-key effects, is that the computer generated background is constantly updated to account for any movement of the studio cameras. The position of the camera in the virtual set sends data to the computer which is used to render the appropriate graphic background.

Taking this concept a step further, researchers at Carnegie Mellon University are exploring the use of camera-generated images of real life as the source from which to build computer generated images of that reality (Kanade, et. al.). Their so-called “Virtualized Reality” technology may be used to re-create three-dimensional VR worlds that accurately portray real worlds without having to build them from "scratch."

Alternative Applications of VR Technology

The immersive VR that has been described so far has largely been the playground of researchers and scientists who have had big budgets and powerful computers. However, the current trend in VR for the masses has been made possible by a different Defense Department computer project—the Internet. The sudden growth and popularity of the Internet and the graphically-rich World-Wide Web (WWW) has resulted in a new computer-mediated medium. It should come as no surprise that VR enthusiasts have rushed to take advantage of the possibilities presented by this new medium.

VRML: The programming language of the WWW is HyperText Markup Language (HTML) a subset of Standard Generalized Markup Language (SGML). In early 1994 Mark Pesce added to these Virtual Reality Markup Language (VRML), for authoring and navigating through virtual graphical worlds on the web. VRML is a computer language that allows users to create virtual objects and spaces that can be explored by anyone connected to the Internet who has the required VRML-capable browser software. VRML has the potential to turn the flat, two-dimensional graphics and information on the WWW into three-dimensional spaces for interactive navigation.
QuickTime VR: Another variety of VR on the WWW is provided by Apple Computer's QuickTime VR. QuickTime VR takes advantage of Apple's QuickTime technology to create virtual worlds that are created from a series of still photographs. Photographs are scanned and then "stitched" together by the authoring software. The final product appears to be a seamless three-dimensional photograph that the viewer can move through, in and around.

The Social Uses of VR

In some VR environments interaction is provided by another human who is occupying the same virtual space. In others, such as single player games, all or nearly all of the interaction is supplied by the many lines of computer code that make up the program. Even then is important to understand that this programmed interaction is a product of human invention by a software engineer. Every virtual world has a human creator. While some VR critics warn of the dangers of isolation for those who spend extended lengths of time alone in virtual worlds, others envision a new social context for communication in which global virtual communities are formed around shared interests.

Text-Based VR: The fantasy role-playing game Dungeons and Dragons is widely understood to be the inspiration for computer fantasy worlds called MUDs. MUD at one time stood for Multi-User Dungeon, but now more commonly means Multi-User Domain. Text-based MUDs have evolved to become object-oriented MOOs (MUD, Object-Oriented), moving closer to the concept of VR. In both MUDs and MOOs, participants create a persona or avatar, contribute to building a simulated environment, and interact with other participants.[8]

In contrast to the immersion VR systems described thus far, text-based VR facilitates the construction of virtual worlds with readily available materials—a computer keyboard and a willing mind. These virtual worlds are created in cyberspace and are populated by computer enthusiasts seeking to engage in mediated human interaction. As physical spaces become increasingly dangerous and uninhabitable, virtual spaces of our own construction become increasingly attractive. Virtual realities allow us to modify our identities, improve our appearance, and control our interactions with others. As users of MUDs and MOOs have known for some time, creating an avatar to operate in a fictive dimension is an intoxicating experience.

These virtual worlds are real in so far as they represent the interactions of humans in real-time. The creation of reality in this case is a social construction, rather than the biological, sense-based artificial reality of what is traditionally known as full-immersion VR. One could argue that this socially-constructed, text-based VR experience is immersive in a different sense of the word. Reports of "addictive" behavior have been attributed to MUDDing and related activities.[9]

Virtual Sex: One of the more lively topics of discussion in VR circles and the popular press is virtual sex or "teledildonics."[10] There have been several scholarly treatments of the phenomena (e.g., Deuel, 1996; Lipton, 1996; Adams, 1996), as well as keen popular interest. Deuel (1996), in reference to text-based VR, wrote, "Vsex is immensely popular and pervasive in virtual communities" (p. 131).

Virtual sex is frequently promoted as all the fun without the hassles. Deuel (1996) cited Branwyn who wrote, "Compu-sex enthusiasts say it's the ultimate safe sex for the 1990s, with no exchange of bodily fluids, no loud smoke-filled clubs, and no morning after". Nor is there any need to present yourself as you exist "in real life" (IRL); e.g., weight, hair color, age, or gender. But virtual sex is not without consequences. The now infamous account of forced sex, or "virtual rape" as described by Dibble (1993) and critiqued by MacKinnon (1997), which took place in the LambdaMOO in March 1993 raises some
It is this sensitive area where words become actions that draws the line between protected speech and dangerous speech. Adams (1996) quoted Dibbell: "I did not, however, conclude as a result that rapists were protected in any fashion by the First Amendment. Quite the opposite, in fact: the more seriously I took the notion of virtual rape, the less seriously I was able to take the notion of freedom of speech, with its tidy division of the world into the symbolic and the real. . . . [Here we find] the conflation of speech and act that's inevitable in any computer-mediated world. . . . I can no longer convince myself that our wishful insulation of language from the realm of action has ever been anything but a valuable kludge. (Dibbell 1993, 42)."

One of the many dangers of cybersex is the effect that fantasy has on reality. Sociologist and MIT professor Sherry Turkle, author of The Second Self and Life on the Screen was quoted in an interview for Wired magazine (April, 1996, p. 165), "Is online sex like having an affair? Is it my business because I'm married to you? Or is it like you're reading pornography and it's none of my business?" Besides the obvious questions that this quote raises, one could argue that reading pornography is an issue for a spouse. Whether it is presented as text, photographs, video, phone sex, or full immersion virtual reality, pornography will have deleterious effects on a healthy marriage relationship. The interactive nature of phone-sex, hot-chat, or virtual sex presents additional concerns: one of which is the presence of the "other" person and the increased chance that the act could be consummated in IRL.

**Future Scopes**

Everything is a dangerous drug except reality, which is unendurable. - *Cyril Connolly, The Unquite Grave (1945).*

Today, we have virtual reality like “second life” – a flat, on the screen projection of a virtually created world. Despite it being in the early immature stage, we still see how it has grown up to replicate our real world – virtual concerts, playgrounds, social life and all kind of activities. The second step has been with the eye glasses augmenting a fully 3D visual environment. In coming ten years, these technologies are going to be as realistic as our own world. In twenty five years, we can even hope to see nano-bots that go in our blood stream and up to our brain, interacting with our biological neurons and extend our memory and perception about the real world, augmenting the environment completely.

Some other demanding future aspects of Virtual Reality -

- **Education**: Advances in distributed VR can help break the limitations of classroom teaching, but consider the situation where we can make a virtual trip to places, nuclear laboratories, speak native languages along with people around, perform experiments safely.

- **Training**: The scope is endless in this field. In military training, parachuting, enemy combat, weapons training and hand-to-hand combat can be simulated through virtual training. Astronauts can get a virtual experience of flying in a spacecraft experiencing zero gravity and other situations.

- **Sports**: Studies on athletes have shown that imagining moves on the field are 80-85% of actual physical training which indeed is a good sign when it comes in terms of virtual reality.

- **Inter-personal communication**: Experts have long said that 80 to 90-percent of all communication is non-verbal. Future virtual reality will help bridge this gap in that if we were to meet someone in a virtual space we could observe body language, facial expressions, hand gestures and put it all together with the content and tone of the other person’s speech.
Conclusion

“There is no reality except the one contained within us. That is why so many people live such an unreal life. They take the images outside them for reality and never allow the world within to assert itself.” - Hermann Hesse, Demian (1919).

What do we make of a world where actions have no consequences? Herbert Zettl questioned the ethics of a VR world in which there is no accountability for actions taken and choices made. He wrote - In a way, virtual reality provides a perfect existential world, in which we can exercise free will and make any number of decisions, however extreme, without the Kierkegaardian 'dizziness of freedom' and the underlying anxiety of accountability (Kaufmann, 1956, p. 17).

Today VR technology is still in its infancy, and there are damaging flaws. Graphics, no matter how impressive, are not lifelike. Time lags are far too long. Optic and auditory hardware are not 100% realistic. Users can walk into walls or pick up an object without feeling a thing. The equipment is still far too expensive for everyday use. But each and every one of these drawbacks is the subject of intense research and work; the problems are being overcome, and VR is poised for its major breakthrough.
REFERENCES

1. For more on stereoscopic photographs see URL: http://cmp1.ucr.edu/exhibitions/km_collection-text.html

2. Rheingold credits Morton Heilig with patenting the first head-mounted stereophonic television display in 1960 (1991, p. 50). Heilig's Stereoscopic Television Apparatus for Individual Use was awarded US patent #2,955,156 on October 4, 1960 (p. 58).

3. According to Rheingold, "A human being sees 155 degrees vertically and 185 degrees horizontally" (1991, p. 54), while according to Biocca (1992b) the normal field of view "measures approximately 160 degrees horizontally by 120 degrees vertically" (p. 35).

4. According to Moore's Law, credited to Intel co-founder Gordon E. Moore, computing power doubles, and price is reduced fifty percent, every eighteen months.


7. In Travels in hyperreality, Umberto Eco (1986) describes the trade-off when comparing travel to virtual travel. "When, in the space of twenty-four hours, you go (as I did deliberately) from the fake New Orleans of Disneyland to the real one, and from the wild river of Adventureland to a trip on the Mississippi, where the captain of the paddle-wheel steamer says it is possible to see alligators on the banks of the river, and then you don't see any, you risk feeling homesick for Disneyland, where the wild animals don't have to be coaxed. Disneyland tells us that technology can give us more reality than nature can" (p. 44).

8. The avatar reflects the personality, and often the alter ego, of its creator. Because it is a social construction, the avatar allows the participant to explore dimensions otherwise inaccessible in real life.

9. Beaubien (1996) cited the addictive nature of MUDs as the basis for their being banned from Amherst College and from the continent of Australia (p. 180).

10. According to Rheingold (1991), "The word 'dildonics' was coined in 1974 by that zany computer visionary Theodore Nelson (inventor of hypertext and designer of the world's oldest unfinished software project, appropriately named 'Zanadu'), to describe a machine (patent #3,875,932) invented by a San Francisco hardware hacker by the name of How Wachspress, a device capable of converting sound into tactile sensations. The erotogenic effect depends upon where you, the consumer, decide to interface your anatomy with the tactile stimulator. VR raises the possibility of a far more sophisticated technology" (p. 345).


