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THE ETHICS OF IMMERSIVE VIRTUAL REALITY

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**INTRODUCTION**

Virtual reality has steadily gained popularity over the past few years, causing technology companies like HTC, Oculus, and IBM to invest significant time into developing the field. This paper will be written in this context. Assuming that I am an employee at a company working on the advancement of virtual reality, ethical issues that emerge will be primarily addressed according to my own values, the NSPE Code of Ethics, and the Biomedical Engineering Code of Ethics. Various other sources will be used to explain the concepts behind virtual reality and the ethical implications of such concepts.

**Immersive VR**

Before any discussion about the ethics can begin, it is essential to provide some context.

Virtual reality, known as “Full Dive” or VR, is defined as a “high-end user interface that involves real-time simulation and interaction through multiple sensorial channels,” such as sight, sound, tough, smell, and taste [1]. It can also be defined as “a computer-generated, immersive, multisensory information program which tracks a user in real time” [1].

Over the past two decades, the virtual reality community has based its development on a combination of earlier work in interactive 3D graphics, user interfaces, and visual simulation [2]. As advancements progress, it only makes sense to apply virtual reality to video games; to be successful, video games require sensory appeal, an user-interactive interface, and plot design. The goal of this would be to connect an individual to a virtual environment to perform functions. This is more effectively explained through the diagram below.

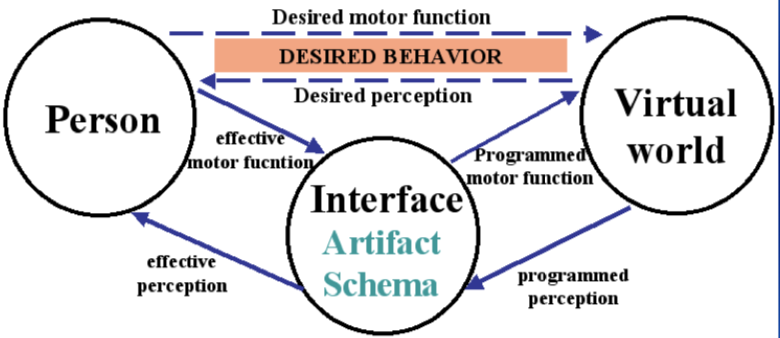


Figure 1, Introduction to Virtual Reality [1].

The type of virtual reality I will be specifically be addressing in this paper is immersive VR. The technology for this is still in its beginning stages of development, but the concept is simple. The VR that is prevalent at the moment allows an individual to move an avatar in a virtual environment, while permitting them to maintain control of their physical body in reality. This control includes various senses; with the Oculus headset that most people are familiar with, users retain movement, sensory input from touch, smell, taste and a limited amount of input from outside sights and sounds. However, immersive VR differs in that it completely blocks out this intrusive sensory input from reality, to completely transport the user to the virtual environment. There, users are completely “immersed” in the environment, hence the name. This method would be based on the orchestrated objective reduction hypothesis proposed by Penrose and Hameroff in the early 1990s. The hypothesis essentially suggests that consciousness in the brain originates from processes inside neurons in microtubules rather than the connections between the neurons, as we so believe now. This hypothesis has recently been brought up again for reanalysis with a 2014 study corroborating this theory [3].

However, this is only the beginning. To begin to manipulate these microtubules would require an in-depth understanding of the brain’s neural networks to target specific areas when connecting to this virtual environment. There have been attempts at creating such an effect with IBM’s SAO Project, but when viewing the uploaded progress video from 2016, it is clear that the project is still underdeveloped [4]. Player movement is clumsy, the graphics are poor, and the design is simple at best. However, such attempts at the manipulation of consciousness brings up many ethical concerns.

**ETHICS OF IMMERSIVE VR**

There are always ethical side effects to tampering with the human body, and even more so with the human brain. Unfortunately, this has prevented a lot of research into the field, as there is not enough known about the brain to predict any negative consequences that may arise. The whole basis of immersive virtual reality is manipulation of the nervous system, or control over the brain’s neural connections. Simply put, this would allow a computer or another person access to an individual’s motor and sensory functions, and to a level, their consciousness. To process this would be to turn this information into data for the computer to understand and carry out commands.

Not only is this a severe intrusion of privacy, this would also invite the possibility of literal identity theft. By stopping connections to reality and instead rewiring them to temporarily connect to the virtual environment, it is then hypothetically possible to copy an individual’s incoming data, or their rerouted neural network, and reproduce it.

This would then theoretically allow anyone who has this data to create a complete clone of an individual, down to their consciousness, simply based on the data that comes from connecting an individual’s senses and consciousness to a virtual environment [3]. Another possibility would be to process the data from an infant and essentially grow an artificial intelligence in a virtual environment. In that case, what would the rights of the subjects, and the artificial intelligences be?

However, such technology can be used for benevolent purposes in the medical field. For example, by connecting to the medulla, but to the spinal cord as well, the user then allows interaction with deeper parts of the brain [3]. This potentially allows for patients who are paralyzed, unable to exit their immediate location, or in terminal care connect to external devices. By connecting to external devices like cameras and microphones, patients can interact with the real world. Or, if they desired, they could essentially live out their lives in a virtual environment [5]. Some therapists have already begun incorporating the current VR systems into their phobia therapies; by exposing an individual to the fearful situation in the virtual world, the individual may begin to have decreased levels of fear in reality [5]. In other words, immersive virtual reality has potential in benefitting the medical field in treatment and maintenance of patient wellbeing.

As an engineer working for a company that is attempting to advance the possibilities of virtual reality, these are all things to keep in mind. Are the risks worth the potential benefits?

**In Accordance with the Codes of Ethics**

I have now identified three main issues with immersive virtual reality. Assuming that I am a biomedical engineer given the responsibility of distributing this technology from a company that wishes to push immersive virtual reality to the general public, I would personally want to address the necessity of immersive virtual reality on a case-by-case basis. For the purpose of this paper, I will use hypothetical scenarios from the medical field to demonstrate how I would act, and how I believe other engineers should act.  
 The first issue suggested is that immersive virtual reality, by its nature, would allow computerized control and regulation of motor and sensory functions. Considering that this could benefit patients in who have little to no control of their motor senses, the benefit would be allowing their consciousness an outlet and a method to interact with the outside world. However, is it ethically right for another individual to be provided access to the controls of another person’s body? According to the Biomedical Engineering Society Code of Ethics, bioengineers must “regard responsibility toward and rights of patients…as their primary concern” [6]. In this case, what would be the right thing to do? Personally, I would consider the specific case that has requested immersive virtual reality and evaluate the case along with the patient’s desires. If the patient themselves desire this as an option, the resource should be provided to them. The benefit of immersive virtual reality is that even if the patient is unable to interact with the healthcare provider in the real world, they would be able to express their needs and be conscious in a separate environment. If the patient is initially unable to express whether they want this option or not, I would choose to provide them with the option, verify their genuine choice in the virtual environment, and carry on from there. Leaving the choice to the patient would maximize the patient’s control over their own body, therefore maintaining their rights over their body. Of course, proper NSPE Code of Ethics guidelines would be followed; the patient would be completely informed, to the best of my ability, about the implications of participating [7]. In general, I would advise other engineers to place the patient’s wishes before anything else, and then ask peers for advice, as these should be the further sources in this scenario.

The second issue is that there is a possibility of information manipulation beyond what is needed for the procedure. Essentially, the implications behind this hint towards preserving an individual’s consciousness in a virtual environment, effectively making death a physical issue [8]. However, this would become something other than a health or engineering issue and begin to fall into the category of personal interest. If it is in the engineer’s personal interest, it would be a violation of the NSPE Code of Ethics line on how “engineers shall not be influenced in their professional duties by conflicting interests” [7]. This may clash with the Biomedical Engineering Society Code of Ethics statement that bioengineers must “regard responsibility toward and rights of patients, including those of confidentiality and privacy…as their primary concern” [6]. In this case, the engineer should do their utmost to protect the confidentiality of the patient, adhere to the Codes of Ethics, and simply apply immersive virtual reality in a healthcare sense. After all, engineers are to “work only in areas of their competence” [7]. In this case, I would stay true to the purpose of immersive virtual reality in healthcare, which is to provide interaction between a patient and the real world, and not to experiment with preserving an individual’s existence. To apply or use immersive virtual reality for anything other than the wellbeing of the patient would be a violation of multiple codes of ethics. If an engineer is having difficulty reaching a decision and making an ethically correct choice, it would be beneficial for them to reach out to other peers, seniors, and to consult family members of the patient to understand what the best course of action would be.

The third issue is that there would be questions about the rights of participants, and the rights of potential artificial intelligences generated by such a project. This type of artificial intelligence, or AI, would be identified as a “bottom up” AI, or an AI that is not programmed to learn specific things but rather mimics the human brain to learn as a human does. This would essentially make it very close to a human, with the exception being that it lacks a physical body. This is where lines blur. A recent similar case would be the artificial intelligence robot named Sophia that has just recently been granted citizenship [9]. Should such artificial intelligences be treated the same as humans? And how indispensable are they? In this case, at least in my opinion, it would be more beneficial to prioritize the patient, the human, over the artificial intelligence. This “bottom up” method could easily allow for professionals to predict future health complications for the actual human patient like a simulation, just many times more accurate. If we take a look at the Biomedical Engineering Society Code of Ethics, there is room for debate on this as the obligations listed under research state that biomedical engineers involved in research shall “comply fully with…ethical…guidelines, respecting the rights of and exercising the responsibilities to…human and animal subjects” [6]. However, we are looking at this from a healthcare standpoint. Under healthcare, the guidelines state that biomedical engineers involved in health care should “regard…[the] rights of patients…as their primary concern” [6]. Keeping this in mind, my conclusion is reasonable, and if questioned, has supporting evidence. If I am particularly unsure about my decision, I would turn to one of my peers or seniors, for their thoughts on the topic.

**CONCLUSION**

It is my personal belief that ethics should be considered through a case-by-case mindset. However, I did find both codes of ethics to be helpful in resolving any disagreement that may occur. My conclusion is that in all scenarios, the patient’s needs and desires for their well-being should be prioritized above anything else, and that biomedical engineers that work in health care, should focus on healthcare and prioritizing the patient’s health. Ethical issues usually arise due to disagreements about how a problem should be correctly addressed. By making the patient the priority, a lot of ethical issues are eliminated, or can be resolved, as that is the treatment that is right for them.

Throughout my discussion of ethics, I repeatedly concluded that consulting peers and seniors in the field would be the optimal choice when in need of help reaching a satisfactory decision. This would make the peers and seniors two further sources. I believe that along with prioritization of the patient, peer and senior input should provide valuable information for any engineer that needs aid in making an ethically satisfactory decision. If any other issues arise, the codes of ethics are always a good way to resolve disputes, as they are a foundation of rules for everyone to adhere to.

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**ACKNOWLEDGMENTS**

Special thanks to Keely Brooke Bowers aiding in the formatting of this paper, and Project Alicization for inspiring the last minute change to the topic of this paper.

**Font size for body text**

* All “body” text: Times New Roman or Cambria 10pt

Font Size and placement for Disclaimer, Name, Titles, Headings, Subheadings

* Disclaimer: Times New Roman or Cambria, 10 pt, full justified , the word Disclaimer in bold, colon after the word Disclaimer
* TITLE: 14 pt. BOLD Times New Roman or Cambria, CENTERED
* Name and email: 10 pt. Times New Roman or Cambria, bold, centered, **email in parentheses immediately after name**
* SECTION HEADINGS: 12 pt. BOLD Times New Roman or Cambria, CENTERED
* Section Subheadings: 10 pt. bold Times New Roman or Cambria, centered

**Spacing for body text**

* Single space (1.0 NOT 1.15, NOT 1.25) for body text in all sections

**Spacing between paper elements (Disclaimer, Name, TITLE, HEADINGS, etc.)**

* Space between Disclaimer and MAIN TITLE
* Space between TITLE and name email
* Space between name (email) and first SECTION HEADING
* Space between SECTION HEADINGS and section/body text
* Space between section subheadings and section text

**Paragraph indent and spacing**

* Set paragraph tab at 0.3; indent all paragraphs 0.3
* Do NOT put a space between paragraphs within columns

**Headers and Footers format and content**

* Headers and Footers: 0.5“
* Header, Page 1: 10pt. **bold**, aligned left

**0011/0711 Section** (for example, Sanchez 10:00)

**Group number** (for example L3)

* Header, *after* Page 1: Your Name, 10pt. **bold,** aligned left
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You may use this template to type or paste your own writing into the formatted title, headings and subheadings, and columns. To do so, you would select/highlight a line (such as a section heading) or a block of text (such as a paragraph) and replace the original text with your own text. Highlighting and "typing over" will usually preserve margins and columns, **HOWEVER, highlighting and "typing over" WILL NOT ALWAYS PRESERVE CORRECT TABS, ALL CAPS, ETC.** If you opt for this strategy, be ***sure* to double-check all formatting specifications** to ensure everything is correct--you might need to "manually" use your toolbar and/or alter your settings to correct various format elements.

NOTE: If you opt for the highlight and type over strategy, be sure that **none** of the original formatting instructions (the “original text”) remains in your paper.

NOTE: There are many “bulleted” sections on pages 1 & 2 of this document—if you are using highlight and type over strategy, be sure you are not putting all of your text into bulleted lists/format.

**STRATEGY 2: USE WORD SETTINGS**

If, instead of formatting via template, you would like to set or double check format specifications via your Word settings, you can “Use Word Settings” as detailed below (and as specified in the “checklist” on pages 1 and 2).

Instead of selecting and typing over text on this template, you may opt to use Word’s settings, menus, and commands to create correct formatting. This method can be helpful if you are continuously revising and refining your draft. While the instructions that follow might look intimidating at first, they simply detail how to use menus and toolbars/”ribbons”—which you already generally know how to use—to set correct formatting.

**Set Margins**

To correctly set your margins, go to **Format**; click on **Document**. Set the **top and bottom margins** at 1. Set the **left and right margins** at .75 (or .7). Set the **Header and Footer** at 0.5.

**Set Line Spacing**

To set line spacing, go to **Format**; click **on Paragraph**. Under **Spacing**, set **Before** at 0, **After** at 0, and check **Don’t add space between paragraphs of the same style**. Be sure **Single** is selected under **Line Spacing**. This will set the correct single spacing (1.0) of lines within your paragraphs.

**Set Paragraph Indent**

Every paragraph should be indented. To set your paragraph indent, go to **Format**; **paragraph**, and click on **Tabs**. Set Tabs at 0.3. When typing your first line of text in a paragraph, hit “tab” and your paragraphs will be correctly indented. Or, go to **Format**; click **on Paragraph**. Under the **Special** menu, click on **First Line**. In the **By** box, put 0.3.

**Set Header, Page 1**

Open the header and type in your 0011/0711 section (for example, **Panza 2:00**).Move your cursor to directly below the start of this line (this will maintain single spacing) and type in your Group Number (for example, **L3**). Be sure your font, text, and alignment are correct: **10 pt., bold, aligned left.**

**Set Footer, Page 1**

Open the footer. Type **University of Pittsburgh, Swanson School of Engineering**. Place your cursor beneath the start of that line (this will maintain single spacing), and type in **First-year paper.** Place your cursor beneath the start of that line (this will maintain single spacing), and type in the **date** on which you are submitting your paper (for example **10.4.2018**). Be sure your font, text, and alignment are correct: **10 pt., Times New Roman or Cambria bold, aligned left**.

Go to **Insert**; click on **Page Numbers**. Under **Position**, choose **Bottom of page (Footer).** Under **Alignment,** select **Center**. Check **Show number on first page**. Be sure you page number is **Times New Roman or Cambria 10 pt. bold**

**Set Header and Footer, Page 2**

For most versions of Word, the easiest way to create a different header and footer after the first page is to go to **Forma**t, click on **Document**, click on **Layou**t. In **Headers and Footers**, click on **Different First Page**.

In your page 2 header, simply put **your name** at the top, **10 pt. Times New Roman or Cambria bold, aligned left**. For your page 2 footer, simply **insert the page number**, **Times New Roman or Cambria, 10 pt., bold, centered.**

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**Set the Column Width**

To correctly set the column width, go to the **Format** menu; click on **Columns**. Set **number of columns** to 2. Check **equal column width**. Set **column width** at 0.3 and **Spacing** at 3.4". All your typing will now automatically appear in the (correctly spaced) 2 columns.

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* The *basic* correct order and punctuation for your bibliographic information in your sources section is this: [number] First Initial of Author. Last Name of Author. “Title of Article.” Larger Source Within Which Article is Located*.* Date of publication mm.dd.yyyy. Accessed mm.dd.yyyy. url or DOI.p.
* For example, for the NASA article, this is what you would put in your Sources section:

[1] D. Weaver, M. Brakus. “NASA Announces Design for New Deep Space Exploration System.” NASA Exploration*.* 5.4.2014. Accessed 9.30.2017.

<http://www.nasa.gov/exploration/systems/sls/sls/html>. p.2

* For further information on how arrange the bibliographic information for various kinds of sources, see the full document **How to Arrange Information in Sources Section**

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* An Acknowledgments section **IS REQUIRED**! In this section, you “acknowledge”—note your appreciation for—individuals or groups (or other types of resources) that assisted you in some particularly useful, important way.
* For example, if you had some serious discussions with your roommate about your paper, you might thank him or her. Or, for instance, a Pitt Tech Consultant helped you solve a complicated computer problem that occurred as you were preparing your paper, you might thank the consultant. Perhaps a Writing Center consultant was very helpful to you as you wrote your paper or perhaps your Peer Advisor gave you useful, practical advice. You might thank the W.C. consultant and/or your Peer Advisor in your Acknowledgments section.
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* You ***must* have a Sources section**, you *might* have an Additional Sources section, and **you *MUST* have an Acknowledgments** section. The Acknowledgments section goes last.