Drowning in Immersion

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Abstract

It is commonly believed, but not proven, that virtual reality attains its power by captivating the user's attention to induce a sense of immersion [1] and presence [2]. This is what sets virtual reality apart from other interface metaphors. However, both these terms have been liberally used to varying degrees within the virtual reality literature.

This paper attempts to step back from the technological issues of immersion and to look at some of the basics of immersion itself. Looking at examples of immersion in reality can help us to understanding what may or may not be required in a proposed virtual reality (VR) system. Using the physical senses as a basis for defining immersion has been discussed and three examples (reality, VR and dreaming while asleep) have been highlighted to show the interplay of external sensory stimulation and internal sense representation.

Key Words: Immersion - Presence - Virtual Environments - Senses

immersion.[1]
1. Dipping or plunging into water or other liquid, and *transf.* into other things.
2. *transf.* and *fig.* Absorption in some condition, action, interest, etc.

presence.[2]
1.a. The fact or condition of being present; being there.
1.b An instance of being present.

1. Introduction

It is commonly believed, but not proven, that virtual reality attains its power by captivating the user's attention to induce a sense of immersion [1] and presence [2]. This is what sets virtual reality apart from other interface metaphors. However, both these terms have been liberally used to varying degrees within the VR literature. Sometimes only immersion is used to encompass both terms and sometimes a further split into physical and mental components of each is considered. The variety of their definitions almost rivals that of the term "virtual reality" itself.

Coomans and Timmermanns [3] define immersion as the feeling of being deeply engaged where participants enter a make-believe world as if it is real. Larijani [4] focuses on immersive graphics as encompassing multidimensional displays (pictures, sounds, tactile effects etc.) wrapped around so that all senses seem immersed and the line between the real and illusionary worlds disappears, while Manetta and Blade [5] look to the mental side of immersion as the observer's emotional reaction to the virtual word as being part of it, and presence being a feeling of being immersed in an environment, able to interact with objects there. Wells [6] centres a description around the person, with presence as a sense of "being there" or of a person or thing "being here". Kalawsky [7] describes

[1] The Oxford English Dictionary, Second Edition, Vol. VII, Clarendon Press, Oxford, 1991
[2] The Oxford English Dictionary, Second Edition, Vol. XII, Clarendon Press, Oxford, 1991

presence as the sense of "being in" an environment as the most important attribute of spatially immersive displays.

There are no set or universally agreed definitions, let alone metrics, for these terms. One reason for this is their subjective nature [8]. Immersion in a virtual reality environment is dependent on many factors, including the users physical senses and mental processes, the technology involved, the types of interaction involved and the tasks of the current application. Many current research efforts have focused on the desire to use technology as the defining factor in immersion. Slater and Usoh [9] describe the term "immersion" as a description of a technology, which can be achieved to varying degrees. They separate immersion from presence by noting that presence is a psychological emergent property of an immersive system. Immersion describes a kind of technology and presence describes an associated state of consciousness.

2. Describing Immersion

Trying to describe immersion on a general level is difficult as the concept is so subjective. The limitations of technology, users experience and the testing domain are all factors that may influence the "immersiveness" of a virtual environment.

One way to look at immersion is to focus on where the user is grounded in an environment. This grounding can be based on a combination of the primary senses (vision, hearing, taste, smell, touch) and secondary senses (propreception, vestibular sense, etc.). In this section, five reality based immersive states are briefly discussed to provide a basis for describing immersion.

The most common immersive state that we encounter on a daily basis is "reality". Although the term reality and its possible definitions can be argued on many philosophical levels, that is well outside the scope of the current paper and much of the VR literature (see [10, 11] for philosophical views into VR). Here, we view reality as a standard, or base level, of full immersion. The subject is physically and mentally immersed in reality and both the users perceived model and mental model of the actual environment match (Figure 1).

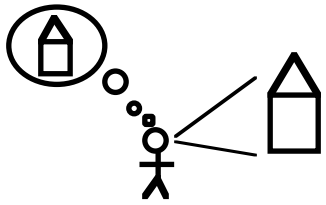

Figure 1 : Immersion in reality.

Two other variations on reality immersion can be seen in Figure 2. Firstly, when a subject is daydreaming, their current environment does not match with their mental model. Oswald [12] notes that some people can have dream experiences when fully awake and in more or less immediate contact with reality. For example, someone could be waiting in a queue and be quite unaware of their current surroundings as they daydream about a past or possible future event. A dream can seem vividly real despite the lack of sensory input [13]. One factor determining the level of "dream immersion" is the subjects level of engagement with their current environment. The less engaged the subject is in reality, the more immersed they are in the daydream. However, with daydreams, there is usually sufficient environmental stimulation present and cerebral vigilance is high enough to enable the individual to keep at least within easy call of reality [12].

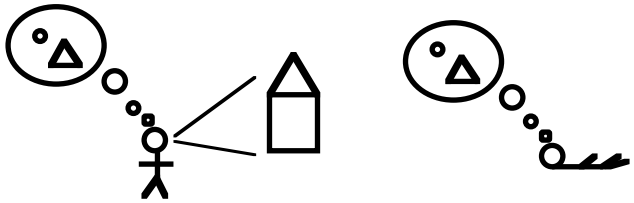

Figure 2 : Daydreaming and dreaming while asleep.

A similar effect is seen in the second example in Figure 2, the process of dreaming while asleep. The subjects senses have has been actively suppressed and there is a lack of stimulation [14], e.g. lying down in a quiet, dark and comfortable place with their eyes closed. The typical sleeping setting encourages reduced sense stimulus and hence lowers the subjects level of engagement with their environment. This can lead to sleep and, possibly, the dreaming mental state. Although detailed descriptions of sleep and dreaming and the associated psychological and physiological effects are outside the scope of the current work, this topic will be further discussed in section 3.3.

Similar to the daydreaming immersive state is the environment that is promoted in cinema theatres. Motion pictures attempt to place the user in synthetically generated environments [15]. Subjects are seated in darkened rooms with enhanced audio and a focused field of view (FOV). The subjects senses are again suppressed and their level of engagement is increased by focusing on their two primary senses, the visual and the audio. The camera provides a view that represents the viewpoint of the viewer and can provide views that a person might see if they were "really there" [16]. This can lead to cinema immersion (Figure 3b). Roberson, Czerwinski and van Dantzich [1] note this effect with cinema, television and some video games.

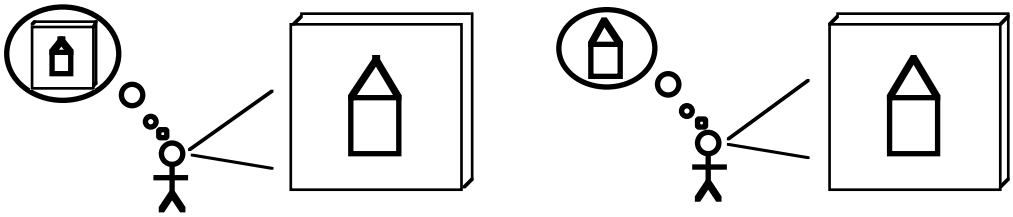

Figure 3 : Cinema (a) without and (b) with immersion.

However, although subjects can reach some level of immersion in cinema, there are many factors that may reduce a subjects engagement with the experience and hence immersion. The subjects interest in the presented material [17], local background noise and the subjects current state of mind are all influencing elements. Also, motion pictures are limited by a narrow field of view; if the viewer's eyes scan to the screen's edge, the illusion is broken [15]. Wann and Mon-Williams [18] observe that moving a subjects' head sideways should produce perspective changes in a natural scene, which is absent in a simple projection onto a two dimensional surface. When this happens, the illusion of immersion is lost and the subject is grounded back in the cinema (Figure 3a).

Textual immersion is another example of reality based immersion. Reading a good book can immerse a reader [19]. Again, the level of engagement with the material presented can determine whether the reader views the material as text (Figure 4a) or becomes immersed (Figure 4b). Some interest in the levels of immersion in textual environments has focused on computer based multiple user environments, e.g. MUD[3]s and MOO[4] [19, 20]. Such research leads to questions about whether the term "textual VR" is sensible. Typically,

[3] Multi-User Dungeons
[4] Object-Oriented MUDs

real time visuals are seen as a necessary part of a VR system. The provision of possible immersion does not necessarily mean a system can be classified as VR.

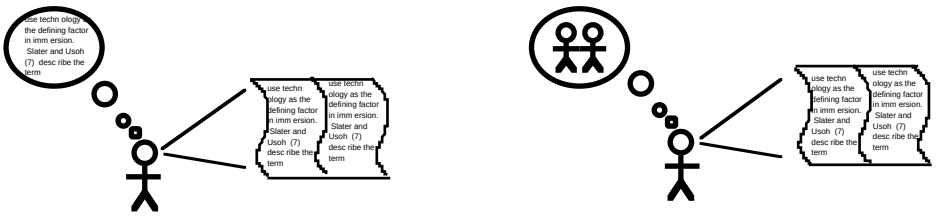

Figure 4 : Text (a) without and (b) with immersion.

3. Stimulus and Immersion

One way to consider immersion and presence is to move away from descriptions of possible psychological properties, which have yet to be defined, and to concentrate on the physical senses. These senses are the five that are directly in contact with our environment, and hence any VR technologies. They are sight (visual), hearing (audio), touch (tactile), taste (gustatory) and smell (olfactory).

Following are three sample immersive environments and how they can be related by the physical senses. (Note that in Figures 5-7, the square around the subject represents the encapsulation of the subject in an environment and the arrows represent current possible stimuli.)

3.1 Reality

The person and their senses are grounded in a real environment and their mental state has them in the same real environment. Cognition involves an interplay between externally derived sensory phenomena and internally generated models and expectations. Hence, the physical senses (focused on a physical environment) are filtered through the persons mental processes (and combined with the subjects current internal processes) to form a mental environment that matches the actual physical environment.

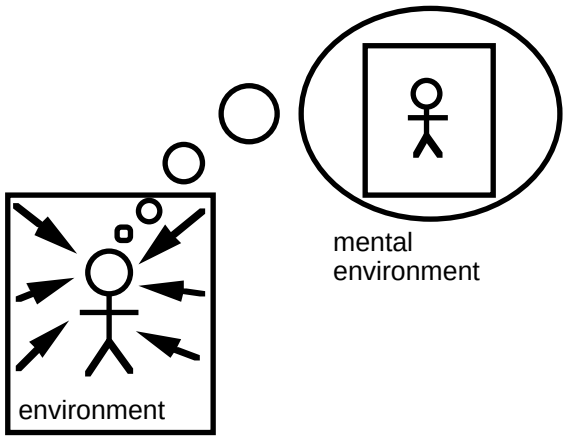

Figure 5 : A reality model.

3.2 Virtual reality

The person is physically based in a real environment but their mental environment is an illusionary one which is constructed by tricking the senses by providing some external artificial sense stimulus. The subject is under the illusion that the VR objects are present in the same environment as the subject [21]. Users perceive themselves as being "inside"

the scene, and they have a 3D spatial understanding of objects' locations with respect to their own body.[15]. This is provided by some "VR box" which effectively blocks some real environment stimuli, e.g. vision and audio. Hand [19] notes that in VR, we are dealing with artificial stimuli which cause us to react in the same way as real stimuli. The subject ceases to think of themselves as interacting with a computer and interacts instead with the 3D environment [1]. Therefore, the subjects physical senses act on an illusionary environment passed to the mental processes to form a mental environment which is different from the actual physical environment.

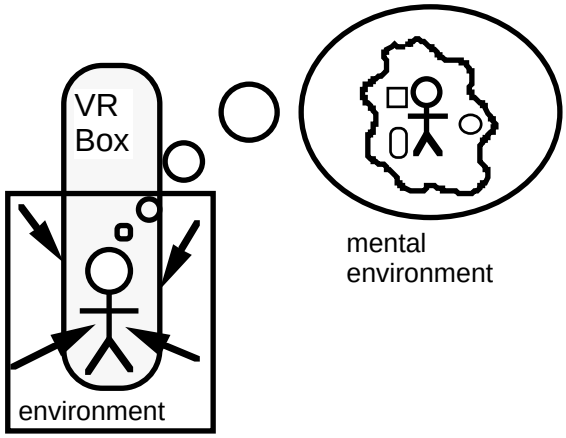

Figure 6 : A VR model.

3.3 Dreaming while asleep

Hand [13] observes that dreams are our oldest experience of a virtual reality. When asleep, the only stimuli to which the sleeper is now sensitive are those generated by the brain, or mind itself [22]. The need to override the current physical stimulus is reduced due to the fact that the physical senses are already suppressed (dashed arrows in Figure 7) through the act of sleeping [23]. The mental environment is typically not controlled by the person. One exception to this generalisation sometimes occurs when we realise while dreaming that we are dreaming [24]. "Lucid" dreams allow the sleeper to take charge of the dreams events [13, 24]. However, in both cases, the provision of artificial stimulus is provided by the persons unconscious mind.

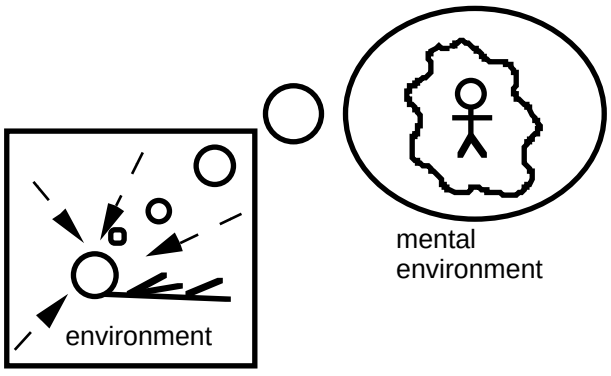

Figure 7 : A dreaming model.

3.4 Sense Stimulus

In each of these examples, the level of immersion is dependent on the strength of the mental environment versus the physical environment as defined by the current sense stimulus. A possible view of this mapping is as a sense of presence. If a persons mental and physical environment have a strong match, then the person has a sense of "being

here" while if the mental and physical environments diverge, the person may have a sense of "being *there*". The "being there" sense is what is typically desired in VR applications. This can be stated as a *mental presence* which is reinforced by increasingly strong degrees of immersion.

Immersion in virtual reality may be able to be mapped to the definition of mental presence (the sense of "being there") by the use of VR technologies. These technologies could be used to override the physical senses and to immerse the user in an illusionary environment.

4. Classifying "Being There"

The next logical step is to try and classify how different degrees of immersion can be obtained and how these can be mapped onto mental presence. The visual sense is usually the primary stimulus in many VR applications but it is typically insufficient to provide the required degree of immersion. The addition of other modalities, for example, audio and tactile senses, can provide an increased degree of immersion. Also, it would be interesting to compare several different combinations of multi-modal input/output, for example, virtual environments based with audio only, haptic only, haptic and audio etc. As well as building a classification of immersion, the use of virtual environments by people with disabilities could be evaluated as some potential users of virtual environment technology may be unable to make use of some modalities due to physical disability [13].

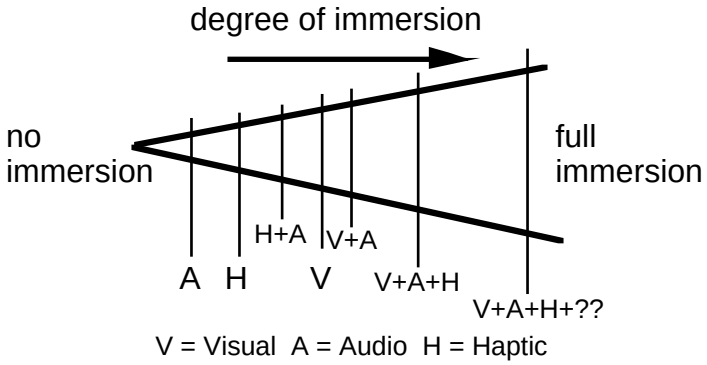

Figure 8 : Degrees of immersion classification.

Due to the subjective nature of immersion and presence, user studies are one way that particular technologies can be evaluated for their degree of immersion. Figure 8 shows the typical VR focused senses with a possible classification based on the degree of immersion. Not only would it be desirable to determine different levels of immersion that each sense contributed to but also to note the difference of scale between modalities. For example, comparing the difference between *haptic only* and *haptic with audio* versus *visual only* and *visual with audio*. Some measure of each sense may then be able to be specified. This will be important as we design and build systems that address all of our senses; what Astheimer calls "perceptualization systems" [25].

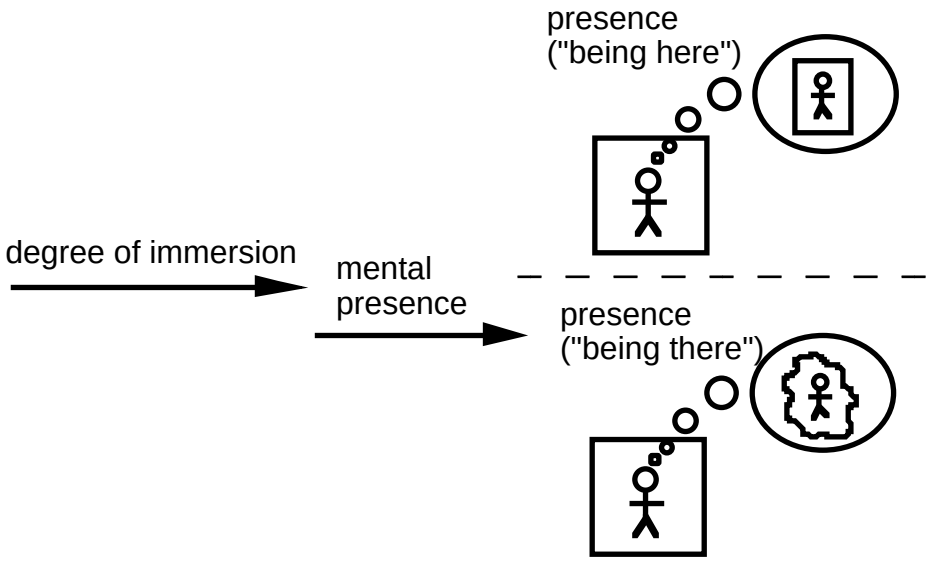

Figure 9 : Getting to "being there".

As noted previously, a goal of many VR systems is to achieve the "being there" feeling of presence. Increasing the degree of immersion can increase the likelihood of mental presence and hence provide the level of presence which is required (see Figure 9).

5. Conclusions

Proponents of VR have held that immersion is critical to VR and can best be attained by fully visually immersing the user with a head mounted display (HMD) or CAVE and by driving the user's virtual viewpoint by tracking the user's head movements [1]. This focus on visually immersing the subject is common throughout VR research.

What we have done here is to step back from the technological issues of immersion and to look at some of the basics of immersion itself. Looking at examples of immersion in reality can help us to understanding what may or may not be required in a proposed VR system.

Using the physical senses as a basis for defining immersion has been discussed and three examples (reality, VR and dreaming while asleep) have been highlighted to show the interplay of external sensory stimulation and internal sense representation.

As with many of the terms involved with VR, immersion and presence have become the "buzz" words of specific technology and have drifted from their pure definitions. This has clouded many of the issues involved with VR research and has influenced popular option of the field. Pulling immersion back to basic definitions can help to focus on what we mean by immersion and hence can be used as a stepping stone to answering such questions as what immersion is and how it can be measured.

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