How Does Light Shape the Environment and Affect Human Perception in the Virtual Environment

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ABSTRACT

This paper introduces the virtual reality technology and its created environment, which immerses the experiencers, and uses the lighting effect to affect the experiencers' perception, so that although the experiencers were informed to be in the virtual environment, they are still almost completely attracted by their attention and reacted according to the environment in the scene.

Keywords: *VR   Light   Human perception*

1.INTRODUCTION

VR is an interactive environment that can participate. It is characterised by the illusion of actively engaging with the environment, rather than just viewing the environment from the outside. At present, it requires some 3D, stereoscopic, head-tracking displays, hand/body tracking and binaural sound support [4]. VR is a multi-sensory 'immersive' experience, also known as virtual environment, virtual world or micro-world [4]. Virtual reality has the potential to provide additional power by improving people's perceived fidelity. The development of VR technology could have an impact on the whole society [4].

A virtual environment can induce a sense of presence, which is a psychological experience created by computer simulating the world [1]. Immersive computer technology is increasingly being used to explore potential ways to increase human empathy. Because the sense of 'immersion' experienced in virtual environment is enhanced, virtual reality (VR) technology is considered to be the ultimate empathy machine [2]. Immersive virtual environment allows the experiencer to leave the current real environment and location, and the sense of existence felt in the virtual environment is a virtual world phenomenon created by computer[3].

Light can not only change the complexity and diversity of space and determine the way we perceive, but also guide us to see things, change the visible colour, and inform our perception of the shape of space [5]. Just as the Finnish winter sun and the Los Angeles summer sun create completely different sensations, light shapes the sensory and emotional experience of different regions [5]. While, artificial light is a medium or field that provides perception of objects, such as sunlight, through a combination of various elements that make up the infrastructure [5]. Different types of lighting and their applications have produced a myriad of unique lighting scenes, which provide various conditions for perceiving and understanding the world [5].

2.VIRTUAL AND LIGHTING

2.1 Virtualised environments and Feelings

Virtualisation is defined as the interpretation of the patterns seen by the human-experiencer in the sensory impressions of objects expanded in the environment rather than the physically present one. This definition comes from the field of optics, which means that physical existence corresponds to virtual real objects [3]. However, in the virtual environment, there is no virtualisation of the corresponding physical object, and the participants are treated as part of the environment. The movement of the head produces motion parallax at the view of the participants, stimulating the vestibule and other physiological reactions related to focus and object tracking [3]. The important parameters of immersion include visual field, the number of sensory systems simulated by the system, different rendering quality of each sensory mode, different tracking range, different authenticity of different image realities, as well as the time and latency between event start and system

response [3]. In this process, it is important to match the simulated sensory data with the experiencer's proprioception, and how the computer system can quickly and accurately describe the relevant visual and auditory effects when the experiencer turns his head. Besides, it is significant to decide whether what the experiencer sees in the virtual space is consistent with his movements. Experiencers are able to influence virtual objects through their actions, thus also affect the changes in the virtual environment, allowing them to control things, initiate and intervene in virtual events [3].

2.2 Light Art and Feelings

Gernot Böhme (2010: 29) pointed out that the development of electric lighting is closely linked to the modern aesthetic experience. The mastery of light and sound by modern technology enables people to obtain new perceptual pleasure and master the material technological shaping [5]. The influence of light on senses and emotions remains unchanged [7]. Light is commonly understood as the quality of daylight, the seasons, the time and place of day; or regarded as bright, dim, blinding, luminous, animated or saturated; or a guide of the path ahead; or can be a practical tool to illuminates various places. When viewing works of art, there will also be some form of light or darkness, which is beyond the normative experience [6]. However, there are few theoretical explanations for the effects of light and dark on sensory organs. Therefore, this paper briefly summarises how brightness, colour, saturation, hue, animation and shadow have a profound impact on apprehension, mood and atmosphere. These qualities appear to be relatively common, so that few people question their influence or significance [6]. The artistic application of light can generate a deep impression of place, space and landscape quality, how space is perceived, the meaning of lighting, and the emotional and affective resonance inspired by light. Some artists have used and demonstrated the power of light and how the interaction between light and the landscape where the work is located affects the sensory and emotional quality [6].

3.LITERATURE REVIEW

3.1 Presence in a virtual environment

In 1980, Minsky introduced the concept of telepresence to describe the sensations that operators can experience when interacting remotely [3]. The operator sees with his eyes, manipulates the effector with his limbs, transforms the 'machine body' into a human body, and then creates the sensation of being in a different place. In this case, when immersed in an environment implemented by a computer-simulated system, the person may be able to influence changes in the environment [3]. Immersing in the virtual environment, users can not only see the view provided by the device, but also experience a more realistic virtual environment and interact with the scene. This interaction will greatly enhance the realism and improve the potential of user experience research [14]. Stereo vision is an important key to the accuracy of perception in virtual environment. In some studies, in addition to depth perception, stereo vision is also considered to be important for many assessment concepts [14]. In addition to the accuracy of the virtual scene simulation, 'presence' is an emerging factor that creates and fully replicates the experience of real space experienced by the experiencer in a virtual environment [14]. The factor analysis of Schubert et al. identified the immersion of 'presence', which determined the three dimensions of people's self-reported presence, namely spatial presence, participation and authenticity. Users' perception of virtual space corresponds to these factors, such as the lack of awareness of the real world, or the perceived realism of the virtual scene compared with the real environment [15].

3.2 The overall ambience shaped by light of the environment

The imaginative use of light can keep the experiencer away from this place and evoke perceptions about other times and places [6]. Although professionals in film, theatre and architecture often rely on physical models to visualise spaces, new technologies such as VR can now be used to help immersive experiences and provide a correct perception of depth and proportion [11]. Lighting plays an important role in the design of 3D virtual environments. Filmmakers, animators and theatre directors discussed the importance of lighting in arousing certain emotions and directing the attention of the experience to the important elements of the scene [12]. Neuroscience and psychophysics have identified several features such as contrast, eccentricity and symmetry, as wells as the division of visual attention associated with lighting [12]. As a result, these characteristics of light have led to the use of light's features in films and theatres to establish visibility and create atmosphere, so as to develop the techniques of constantly adjusting scene lighting to adapt to many important functions [12].

Increasingly, artists are creating immersive environments where the sensory and emotional experience of the experiencer has become paramount. In these works, there is a strong atmosphere of light, water and air, as well as sound, smell and texture. When the experiencer focuses on the emotions and senses of light, the artwork easily distinguishes the experiencer from the habitual experiencer of space [6]. The artists have also investigated the emotional and sensual sensations offered by light. In the Turbine Hall of the Tate Modern in London, a giant artificial sun and a meteorological

project made famous by Olafur Eliasson, will envelop visitors with light and completely immerse them in its glow [6]. Besides, The Blind Light created by Anthony Gormley is a translucent glass chamber, illuminated by fluorescent lights and filled with dense steam clouds, which limits the field of vision of experience. The surrounding mist has almost little sense of scale or distance, while the existence of others can only be felt when they are close [6].

3.3 Atmosphere and mood

Atmosphere is composed of light, darkness and many other components. The atmosphere can be used as a series of events and sensory flows, resulting in the process of immersion, participation, distraction and attraction. Whereas people can convey emotions through gestures and vocal expressions, the reaction and communication methods of these effects will also produce atmosphere [5]. Böhme emphasised that the atmosphere can surround a person, and further explained how the atmosphere can well regulate a person's emotion, but also expand the emotion itself [5]. Like other components of the atmosphere, light is just another element in the built environment that subject to assessment and symbolic understanding [5]. Reactions to different designs, colours and lighting can affect response, resulting in different emotions of excitement, joy, sadness, discomfort or hostility [5]. In an atmosphere, a person is immersed in an experience flow in which emotion, feeling and meaning are inextricably linked. Just as many popular light fittings in Blackpool are featured by characters and motifs from popular culture, visitors will have emotional responses according to what they see (positive or negative). At the same time, they will also convey the quality of flash, animation, colour, intensity, temperature and glow. As a form of lighting, these elements will arouse symbolic significance [5]. Bondi and Davidson (2011: 595) asserted that atmosphere can embody the blurred conceptual boundaries between emotion, meaning and feeling, and that light can also distinguish this elusive division without fixed shape [5].

When considering the impact of light, Dan Flavin reveals that lighting is not always useful for mere figuration. According to Flavin, minimalist works exaggerate the artist's use of colour, enhancing spatial applications and mixing colours, colouring people and objects around them and blending them with other light colours [7]. In fact, people have never seen the light itself, but the colour, shadow and brightness that affect the landscape surface and texture, the diffusion of the many textures of the land specified by light agents, and the light refracted by the myriad particles in the atmosphere [7]. Tim Ingold has pointed out that without the incidence of radiation or the excitation of photoreceptors in the retina, the experience of light is impossible, but as an emotional quality, it is like entering a world of irreducible light [9].

3.4 The role the art of light in virtual environments

The artistic application of light can solve the profound problems of space, place and landscape quality, including how space is perceived, the symbolism in lighting, the emotional and affective resonance caused by light, and the sensations solicited by this resonance, the movement of stimuli and the sensation of being activated [6]. To be more specific, several artists enjoy using and displaying the sensory stimulation and emotional experience of natural light to make works that interact with the landscape. For example, Anish Kapoor has used the Cloud Gate in Chicago's Millennium Park to reflect and distort the reflections of large skyscrapers, parks and the sky with its curved surfaces [6]. Similarly, in virtual reality, virtual world and things can be constructed, and lighting can be used to realise the atmosphere and environment desired by the creator. Moreover, the uniqueness of this place can be emphasised by the artistic deployment of computer programs [6]. As the detailed presentation of Yann Kersalé's work by Pierre Auboiron, the intensity of the red light on the roof of the Lyon Opera House varies according to the level of human activity in the building recorded by sensors and cameras. This work reveals 'inner phenomenology' [8]. Similarly, virtual reality virtual environment is a synthetic illusion. VR relies on 3D, head tracking, body tracking and binaural sound to create an immersive, multi-sensory experience [10]. Immersive Virtual Environments (IVE) can be used as an effective platform for lighting simulation; IVE can be visualised through devices such as CAVEs and HMDs, and provide an immersive experience of one-to-one lighting design through 3D computer models [13].

4.ANALYSIS AND FINDINGS

Virtual environments are excellent tools for neuroscience research because they can almost replicate the sensory environment and can be completely manipulated by the experimenter, while creating costly, dangerous and unlikely scenarios that cannot be created in the displayed physical environment [3]. A surprising finding in virtual reality research is that other parameters, such as head tracking, frame rate, sound and interaction method, seem to be more important than the realism of the display [3]. Perceptual research has opened up many paths to isolate the inseparable stimuli in the real world, especially in the study of self-perception. The fact that the individual's senses enter the virtual environment in a magical way suggests that this 'new' body has been internalised in some way [3]. The phenomenon of sensory presence is based on the transfer of consciousness to virtual space. Therefore, in

a sense, presence is consciousness in virtual reality [3]. People immersed in the virtual environment can respond to what happens in the virtual scene. This process may occur when conscious choices are made and unconscious changes occurs in mental heart rate. When the computer-generated sensory data successfully replaces the real sensory data, people can participate in a normal series of command actions to perform tasks by observing and capturing these behaviours and data, and control their environment to a certain extent [3].

Authenticity, participation and spatial presence are the three factors of perceived presence in the virtual environment. The design of the questionnaire item conforms to the three factors of perceived presence defined by Schubert et al. [14]. Figure 1 'Distribution of participants' responses to questions related to their perceived presence' shows a sample of 29 participants' responses to questions related to their perceived presence [14].
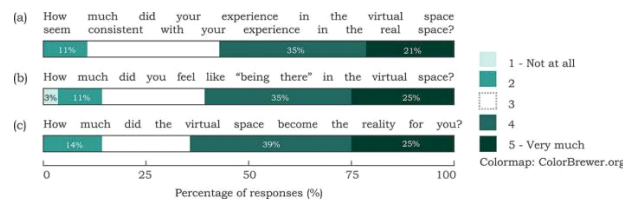

Figure 1. Distribution of participants' responses to questions related to their perceived presence[14].

In this sample size of 28 participants, 56% of participants responded positively and 11% responded negatively when evaluating the congruence between the real world and experiencing the virtual environment (μ = 3.680, σ = 0.94). Regarding the experiencer's sense of presence in the virtual environment, 60% of participants rated it positively and 14% negatively μ = 3.685, σ = 1.09). 64% experienced the virtual environment more positively while 14% experienced it more negatively (μ = 3.750, σ = 1.04).

When studying human perception of colour and light, human vision has never been used to facing scenes with only one colour. People are clearly aware of the process of receiving and experiencing light, but it is also possible that the perceptual organs can alter what people see with their own eyes, because the perception of colour does not objectively identify the outside things, but this is a process. Through this process, the brain understands the stimulation generated when light enters the eyes and reacts with various optic cone cells. Furthermore, photoreceptors in the eye respond subjectively to light conditions [7].

5. CONCLUSIONS

In virtual reality, it is important to have a sense of presence to seize the attention of experiencers and give them a good virtual reality experience. Although every experiencer knows that the virtual environment is fake, when the frame rate is at a certain level or the field of view is just at the correct setting, consciousness may change. At this point, regardless of whether the virtual environment is the real world or the imaginary world, the experiencer will show appropriate consciousness in this case [3]. Lighting designers and artists increasingly expand the meaning, feeling and emotional experience of places through the creative and ingenious use of lights and shadows [5]. The use of light and darkness

has a very important role in the deployment of atmosphere. The use of lighting enhances and regulates people's feelings and emotions of space in various ways. As a medium of artistic creation, lighting is becoming more and more popular, and has been greatly expanded by changing the emotional and sensory quality of place and space experience [5].

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