THE REALITY HELMET: TRANSFORMING THE EXPERIENCE OF BEING-IN-THE-WORLD

John Waterworth
Interactive Institute
Tools for Creativity Studio
Box 7964 , 907 19 UMEÅ, Sweden
john.waterworth@tii.se
http://www.interactiveinstitute.se/tools

Daniel Fällman
Interactive Institute
Tools for Creativity Studio,
Box 7964 , 907 19 UMEÅ, Sweden
daniel.fallman@tii.se
http://www.interactiveinstitute.se/tools

ABSTRACT

The Reality Helmet is a wearable device providing a novel form of interactive experience, in which the user's vision and hearing is completely shielded off from the world. Video and sounds are sampled by the Helmet from the surrounding environment, but through computer processing sounds are presented to the wearer as vision and sights are turned into a soundscape. The result is a radical transformation of the nature of being in the world, an extreme form of artificial synaesthesia. The Reality Helmet leads its wearer to question the relationship between what is out there and what is sensed. Conference participants will be invited to wear the Helmet and experience a different way of being in the world.

Keywords

Reality, synaesthesia, presence, embodiment, wearable.

1. INTRODUCTION

Imagine that you wake up one morning, not as a giant cockroach, but with your senses rewired. You open your eyes and see those parts of the world that were previously sounds: bird song, traffic noise, your own heartbeats and breathing, the rustle of the bedclothes. All these appear as moving, shapes and patterns of colour. Similarly, what were sights are now sounds: as you move your head and eyes to scan the room, you hear a changing soundscape that corresponds to edges, objects, and other visible features of the room around you and through the window. What has happened? A mischievous brain surgeon may have been at work during the night, or maybe someone slipped something unusual into your bedtime cocoa? No, don't worry—it's just that you fell asleep with the Reality Helmet on your head!

The Reality Helmet is a wearable computer system developed with the purpose of providing its users with *altered interactive experiences of reality*, a form of art in which users are actively involved in creating their own, individual experiences of the world around them. Physically it consists of a custom-made helmet that the user wears, and computational equipment placed in a custom built backpack, which allows a high degree of mobility for its wearer (Figure 1).

On the Helmet are mounted a digital video camera and stereo microphones. On its inside, perceived by the user only, are a pair of small visual displays and headphones. As shown in Figure 1, the eyes and ears are completely covered when wearing the Reality Helmet, and so users become audio-visually shielded, while their other senses are not interfered with. Thus, while immersed in what can be seen as a personal virtual environment, users still have the benefit of spatial freedom, which differentiates the Reality Helmet from most other virtual environments.

Through computer processing, the Reality Helmet alters the user's perceptual experience by providing a real-time visualization of the auditory environment in which the wearer is situated and, likewise, a landscape of sound generated from the digital video input. Hence, the user sees what she would normally hear, and hears what she would normally see.

In addition to its primary role as an unusual kind of art installation, the Reality Helmet is being used to examine research questions about the nature and scope of digitally mediated experience. One such area is the concept of virtual presence, where our prototype challenges the argument that presence requires a high

Proceedings Volume 2 of the Conference
HCI 2003: Designing for Society
Bath, UK, September 2003

degree of 'realism' (fidelity to the real world – as normally perceived), something which is often sought in VR. This work thus resonates more with those who primarily seek to provide users with extraordinary bodily experiences, rather than with "accurate" simulations based on a fixed view of what is real [2].

Figure 1 – The Physical Set-up of the Reality Helmet

2. HELMET IMPLEMENTATION

The Reality Helmet embodies two separate software systems which operate continuously on a Linux-based laptop carried by the user in the backpack. The first of these two software systems connects the microphones, facing outwards from the Helmet, with the display glasses mounted on its inside. This application reads the input stream from the microphones, performs a real-time frequency analysis of the sound in stereo, and uses that information to feed an ongoing, real-time visualization. A plug-in visualization system is utilized, which allows many different kinds of visualizations to be used with the data provided by the frequency analysis application.

The second of these two parallel software systems connects the digital video camera, mounted on the Helmet facing outwards in front of the user, with a pair of headphones attached inside the Helmet. This application reads the video stream provided by the digital video camera, and performs an image analysis in which changes that occur over time between different frames are used to find and track visual objects.

The top left segment of Figure 2 shows the current frame, F_i, from the camera. The top right image is a merge, M_i, of previous frames: $M_i = F_{i-1}\,\alpha + M_{i-1}\,(1-\alpha)$, where $\alpha \in [0,1]$, which when applied gives the image a certain motion. The bottom left segment of Figure 2 shows the image after a threshold operation has been applied to the absolute difference between F_i and M_i. The bottom right image shows how a sound source has been connected to the visual 'blob'—a set of interconnected pixels, i.e. pixels touching other pixels in four directions—resulting from such an operation.

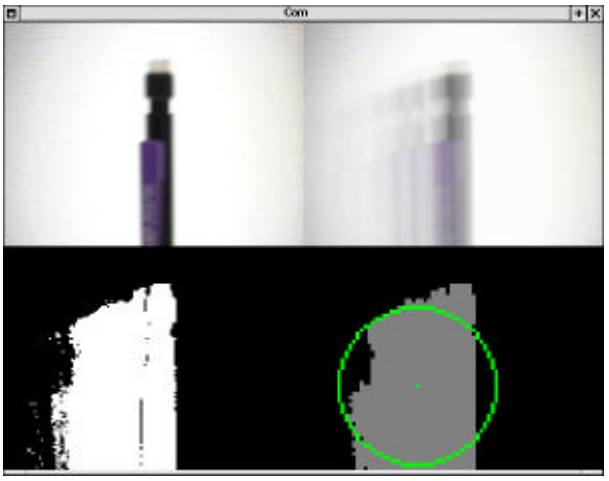

Figure 2 – Image Analysis

The application assigns a sound to each of these objects found in the video stream, and continues to track those objects for as long as they appear. The largest blobs are singled out and their centre points calculated. The size of any given blob is used to determine the volume of the sound source that becomes associated with it. The position of the centre point in the horizontal direction determines the position of that particular sound, which may change in real-time and appear to the user as moving around the soundscape.

As there are typically a number of visual objects recognized and tracked simultaneously, a real-time generated soundscape is provided. Users are able to track objects moving in front of the them, by hearing a specific sound in the soundscape move for instance from left to right. Additionally, a rich, ambient sound, which provides a pleasant backdrop to the dynamic sound effects, is also continuously played in the background, where its amplitude is decided by the current level of change in the visual field as a whole.

3. DESIGNING REALITY

The design space for sensory transformation is almost infinitely large, and the way it was initially designed for the Reality Helmet is probably not ideal for many (if any) practical purposes. But there is no doubt that wearing the Reality Helmet is an extraordinary interactive experience.

In one of the visualizations developed for the Reality Helmet, users experience travelling slowly through a tunnel, whose end represents 'now'. This now, i.e. a visual representation of the current auditory environment in which the user is but cannot hear, is reflected onto the walls of the tunnel, which thus become visual histories of sound moving towards the user, eventually passing by.

The tunnel's colour and character, together with the simultaneous soundscape, have made users describe having the experience of swimming, travelling though space, or falling into a bottomless well. In a second visualization, users experience a landscape coming towards them, with mountains, plains, and water. Similarly to the tunnel, the horizon represents 'now', while the landscape generated from the sound environment, which is slowly coming towards and passing the user's experienced position, comes to operate as a kind of history of sound, provided visually. Users have described this as a highly unusual experience, as sound generally does not have a history but appears and disappears instantly, a characteristic visual objects on the other hand usually do not have.

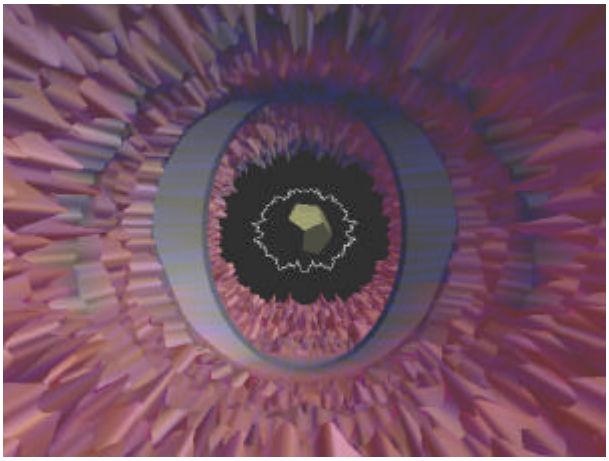

Figure 3 – Sound Visualisation

4. Discussion and Future Work

Apart from sheer curiosity about what it would be like to wear the Reality Helmet, and the effect it would have on others, at least three strands of thought led to its eventual development. Here we reflect on those strands in the light of experience developing and trying the Reality Helmet. We then conclude the paper with a few suggestions for future work and overall speculations.

The original inspiration was an interest in the phenomenon of synaesthesia: the naturally-occurring condition in which individuals experience some crossing-over of sensory channels, such as numbers as colours, tastes as tactile "feels", or sounds as sights. In natural synaesthesia, one sense is never totally replaced by another. Rather, one sensory channel is augmented by another, as when an individual may see certain sounds in addition to hearing them in the normal way. This phenomenon is of interest for several reasons, including the development of a better understanding of conscious perception [1]. Our specific interest originated in the observation that natural synaesthetes (at least the ones one hears about) tend to be unusually creative people [3], as well as the insight that digital technology provides the means to create "synaesthetic media" that can potentially be used to support creative work [12, 13].

Another strand of interest that led to the Helmet is work by philosophers of technology on the relation between people, the world, and various information devices. Ihde [5], for example, emphasizes the distinction between an embodiment relation (as with microscopes, spectacles, hearing aids, a blind person's stick [7]) and a hermeneutic relation (technology such as petrol gauges, thermometers, and so on). In the former, the technology is 'taken into the experience' and changes how reality is experienced, but it does not present a model of reality. In the latter, the technology provides a representation of some aspects of reality, and we could say that an aspect of reality is 'replaced' with a model. Which type of relation does the Helmet exhibit? Arguably, both types.

The wearer experiences a model of the world, but in an 'as-if embodied' way. It is as if his sensory systems are rewired, but they are not. Normally, the models in a hermeneutic relation are mostly conceptual; the thermometer does not feel, look or sound perceptually hot or cold. With the Helmet, a perceptual model is presented, a model of aspects of the world normally experienced through other channels and so modelled in a different way by the brain.

Finally, we were further motivated by our research into the sense of presence, in real, virtual and mixed environments. The common view of virtual presence is that is a function of sensori-motor fidelity and perceptual realism [6]. The Helmet seems to support the view that this need not mean real world verisimilitude [8], a point also made recently by Slater [9, 10]. A popular definition of virtual presence is that it is the "the illusion of perceptual non-mediation" [6]. People do feel present in the Helmet, and this may be because it directs the wearer's attention towards the world around [14], albeit in an unfamiliar way. But wearers do not experience an illusion of non-mediation.

Although in its current incarnation the Helmet does not afford sensory mingling, as in natural synaesthesia, this would of course be possible by simply displaying both original and transformed data streams to the user. However, information overload would be a likely effect of adding sampled sound plus its visual analogue to sampled vision and its auditory analogue. Rather, we are interested in experimenting in the future with the augmentation of individual modalities.

For example, focusing only on what would normally be heard, by allowing auditory and visual display of what

the microphones pick up, might afford new insights into what is usually the exclusive domain of the ears (cf [11]). Highly developed senses, such as vision, could be used to train less developed senses, such as smell.

Other senses, previously unknown to people, could also be simulated in a variety of ways. For example, we could detect infrared, ultraviolet or other zones of the electromagnetic spectrum, and display the results to the eyes or ears. Since sensors exist for a broad range of stimuli not normally detected by humans, the scope for such 'sensory enhancement' is rather wide.

On the basis of our initial trials, the Helmet is appreciated as an interesting experience, an unusual form of interactive art that, perhaps surprisingly, seems to make wearers calm and reflective. But this must depend very largely on the context of wearing. In a safe indoor environment, wearers do not feel they can come to any harm. This allows them to focus almost exclusively on the interactive experience, to relax and have fun.

If we were to test the Helmet in a busy and uncontrolled outdoor environment, the experience would no doubt be very different. Navigating a busy shopping street, crowded with objects, moving people and vehicles, while wearing the Helmet, could be terrifying. We would not attempt such an experiment without safeguards and extensive training, of course. An interesting question is the extent to which one could learn to navigate the world fairly normally while wearing the Helmet, and how such learnability would be affected by variations in the way information is analysed and realised.

There are obvious parallels between the use of Helmet as an interestingly changed experience of reality, and the recreational use of certain chemical substances. One example is the need for a safe environment in which to experiment. Further, the ability of some drugs to produce temporary synaesthesia has long been known, as this quote [4] from Hoffman (the accidental discoverer of the effects of LSD) clearly shows:

> *It was particularly striking [after ingesting LSD] how acoustic perceptions such as the noise of a passing auto, the noise of water gushing from the faucet or the spoken word, were transformed into optical illusions.* [4 p34]

It is notable that he regards the modality-shifted perceptions as illusory, even though they have a real source.

The fundamental questions the Helmet raises are about the nature of consciousness and of the real world – its form and its content. It raises these questions, but as with all art, it doesn't really answer them. We can say, though, that whatever causes us to hear a sound exists, even if we experience it as a flash instead. Similarly, the molecules that result in the smell of a rose could, had we evolved differently, cause a shiver as if feeling a chill wind.

Digital technology allows us to experience what it is like to have a different mapping between world and consciousness. It allows us to design how we experience reality.

It is sometimes said that all reality is virtual, but this seems misleading. Rather, the Helmet suggests that we can see any conscious perception as but one way of realising parts of what is actually out there. The world has real content, but its form is not given.

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