Virtual Archaeology Review

Multi-Sensory Virtual Environments for Investigating the Past

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Resumen

Los seres humanos dependemos de los cinco sentidos: vista, oído, olfato, gusto y tacto para percibir el medio ambiente. Estos sentidos y la interacción que se produce entre ellos es lo que desempeña un papel clave en la comprensión del mundo que nos rodea. La Arqueología virtual cada vez se utiliza más para investigar el pasado. Por ello si no tomamos en consideración todos los sentidos a la hora de realizar reconstrucciones virtuales corremos el peligro real de tergiversar los entornos antiguos y la forma en la que estos entornos pudieron haber sido percibidos por nuestros antepasados. Este artículo describe la Virtualidad Real: entornos virtuales multi-sensoriales de gran fidelidad, y muestra cómo este enfoque puede proporcionar a los historiadores un medio más válido para estudiar el pasado.

Palabras Clave: *ARQUEOLOGÍA VIRTUAL, VIRTUALIDAD REAL, ALTA FIDELIDAD, MULTI-SENSORIAL.*

Abstract

A human depends on all five senses: visuals, audio, smell, taste and touch to perceive an environment. It is not only the individual senses, but also their interaction that plays a key role in enabling us to understand the world around us. Virtual archaeology is being increasingly used to investigate the past. Failure to consider all senses in these reconstructions runs the very real danger of misrepresenting ancient environments and how they may have been perceived by our ancestors. This paper describes Real Virtuality: true high-fidelity multi-sensory virtual environments, and shows how such an approach may give historians a more valid means of considering the past.

Key words: *VIRTUAL ARCHAEOLOGY, REAL VIRTUALITY, HIGH-FIDELITY, MULTI-SENSORY*

1. Introduction

Over the years there have been many computer reconstructions of cultural heritage sites. The vast majority of these have been based on artistic interpretation rather than physical accuracy (MARTINEZ 2001, MILLER and RICHARDS 1994). Those which have accurately modelled, or even laser scanned, the site, have then failed to illuminate the site authentically using the light which would have been available when the site was in use (BRIDAULT et al. 2006, GONÇALVES A et al. 2008).

A fundamental important fact to remember when attempting to recreate real environments on a computer is that humans perceive with all five senses: visuals, audio, smell, touch and even taste. In this perception, crossmodal effects, ie. the interaction of the senses, can be significant, even to the extent that some sensory information may be ignored (MACK and ROCK 1998). This must be considered when using virtual environments to investigate the past. Failure to do so runs the very real danger of misrepresenting the environment and thus how it may have been perceived by our ancestors.

2. Real Virtuality

Real Virtuality is defined as a true high-fidelity multi-sensory virtual environment that evokes the same perceptual response from a viewer as if he/she was actually present, or "there", in the real scene being depicted (CHALMERS et al. 2009). Also known as *there-reality* (CHALMERS et al. 2007), this is a step change from Virtual Reality. By stimulating all five senses concurrently in a natural manner, Real Virtuality exploits human perception including crossmodalities to selectively deliver the right mix of all the senses in real time.

Visuals: Real world lighting is rich in colour and luminance. The human visual system (HVS) can see detail in regions of light which differ by as much as $1{:}10^4$ at any given eye adaptation level. Recently developed high dynamic range (HDR) displays are necessary to represent such lighting as these are 10 times darker and 30 times brighter than traditional computer displays.

Figure 1 shows a Byzantine icon lit by candle light displayed on a typical high definition LCD display, and the same image displayed on a modern HDR display. As can be seen, an LCD display cannot show true black, and thus the visual quality of the image is impeded by the "glow" of the LCD. This does not occur on an HDR display (ZÁNYI et al. 2007a). It is also necessary to take into account how the human eye may have adapted to prevailing light conditions (CHALMERS et al. 2006).

Audio: Sound in the real world is directional and is heard outside the head (unlike the audio delivered by current mobile devices which is perceived "inside the head"). The individual nature of a human's head, shoulders, and folds of the outer ear, the pinna, directly affect how we perceive sound (HOWARD and ANGUS 2006) and thus must be considered when accurately modelling any virtual audio reconstruction.

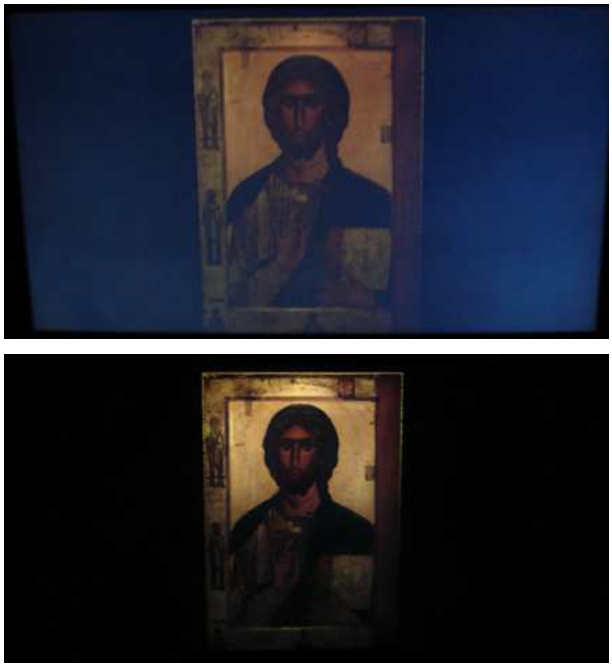

Figure 1. Visuals on a (top) LCD display, and (bottom) HDR display.

Smell: Smell is a primal chemical sense for humans. The sense of smell can affect mood, memory, emotion and even mate choice. Despite this importance, smell is seldom included in virtual archaeology. The Jorvik Viking Museum in York, UK, has been using smell to enhance their real exhibits for many years. The presence of smell at this museum has also been shown to help visitors remember information (AGGLETON and WASKETT 1999).

Taste: Research on the perception of taste started as long ago as the late 1500s. Although, like smell, taste is a primal chemical human sense, very little work has been done to include taste in virtual environments. In 2003, Iwata et al. presented their food simulator which mimicked the sound and feel of chewing, while at the same time delivering limited chemical simulation via a micro injector (IWATA et al. 2003).

Touch: Some form of haptic interaction is a key component on many virtual reality systems. However, the limited feedback capabilities of virtual haptics are a long way from matching the human tactile sensory system (SADDIK 2007).

3. Case Studies

3.1 Byzantine church of Panagia Angeloktisti

Built during the early Byzantine period, the church of Panagia Angeloktisti at Kiti, close to Larnaca on the island of Cyprus, still contains a well preserved apse mosaic from the 6th century. The mosaic comprises the Virgin Mary holding the Child with the Archangel Gabriel on the right and the Archangel Michael on the left (FOULIAS 2004), Figure 2. Byzantine churches were deliberately unimposing from the outside with little decoration, no paint or precious materials. The interiors were very different, presenting a highly multi-sensory experience. The architecture was deliberately designed to use light and shadow to symbolically represent different sacral hierarchies and direct the attention of the viewer (PEERS 2004). The dramatic visual effects were enhanced by the rich nature of the chanting used for services, the strong smell of incense and the significant temperature change from the heat outside to the cool interior of the church.

Figure 2. Capturing the apse mosaic (ZÁNYI et al. 2007b)

3.2 Egyptian temple of Kalabsha

Build in 30BC, the temple of Kalabsha was dedicated to the Nubian fertility and solar deity god Mandulis. The walls are covered with text and inscriptions depicting Egyptian deities such as Isis and Osiris. With the building of the Aswan dam in 1963, it was necessary to dismantle the temple to save from being submerged under the waters of Lake Nasser. In 1970, the temple was rebuilt at a new location above the dam level, and due to limitations of the chosen site, at a different orientation (WRIGHT 1972). The multi-sensory perception of Kalabsha in the past would have been dominated by the heat of the Egyptian sun, Figure 3, contrasting with the cool interior of the inner sanctuary, and included the quiet prevalent in the interior and the smell produced by the sesame oil lamps. A key feature of any authentic reconstruction of this site, and others in Egypt, is the need to include the ever-present Egyptian dust (KAHNERT 2003), Figure 4.

Figure 3. Daylight at the Temple of Kalabsha at 9am on 21 January (a) photograph 2003 (b) daylight simulation 30BC (SUNDSTEDT et al. 2004)

Figure 4. The impact of dust in the perception of the inner sanctuary of Kalabsha. Image courtesy of Diego Gutierrez,University of Zaragoza

3.3 Prehistoric cave art at Cap Blanc

Overlooking the Beaune valley in the Dordogne, France, the site of Cap Blanc contains dramatic Upper Palaeolithic haut relief carvings. Carved some 15,000 years ago, the frieze comprises horses, bison and deer. Today the site is enclosed in a museum and the frieze is lit by modern halogen lamps. As Figure 5 shows, the perception of the site is now very different from how it may have appeared 15,000 years ago when it would have been lit by animal tallow lamps (ROBSON BROWN et al. 1999). Modern light is static and thus very different from the flickering lamps of the past. It is intriguing to speculate whether the dynamic nature of flame, coupled with the careful use of three-dimensional structure of the carving, and perhaps some early music and the cool of the overhang at Cap Blanc or the constant 12°C of other painted cave art sites in the region, may have been used to create animations 15,000 years ago [CHALMERS et al. 2000].

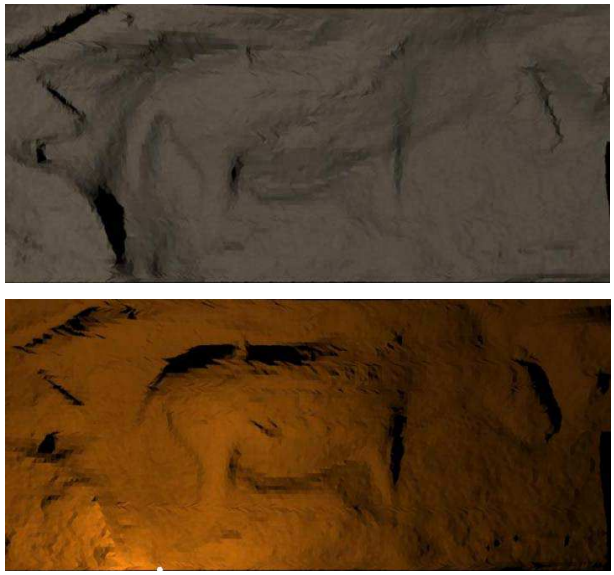

Figure 5. Reconstruction of the Cap Blanc horse frieze lit by (top) simulated by 55W halogen light as the site is seen today (bottom) simulated animal tallow candle as the site may have been seen some 15,000 years ago.

4. Conclusions

As with all historic reconstructions, great care needs to be taken to ensure that all available evidence is included in the virtual model. As humans perceive real environments with all five senses, such virtual reconstructions need to consider the authentic representation of each of these senses. Accurate delivery of these individual senses will allow the human observer's natural perception system to account for any crossmodal effects.

We will, of course, never know exactly how our ancestors may have perceived any site. By ensuring we deliver a true high-fidelity multi-sensory reconstruction of it, we have at least a higher probability on obtaining a more accurate understanding of the past.

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