Interfaces for virtual environments; a review recent developments and potential ways forward

Michael W. Knight, Andre G. P. Brown

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Virtual Environments, games engines, collaborative design, navigation metaphors

Abstract

The physical and visual nature of the interface devices and media that enable the human agent to interact with a virtual world have evolved over the past few years. In this paper we consider the different lines of development that have taken place in the refinement of these interfaces and summarise what has been learned about the appropriate nature of the interface for such interaction.

In terms of the physical aspects we report on the kind of devices that have been used to enable the human agent to operate within the computer generated environment. We point out the successes and failures in the systems that have been tried out in recent years.

Likewise we consider the kinds of software generated interface that have been used to represent virtual worlds. Again, we review the efficacy of the environments that have been devised; the quality of the Cyberplace. Our aim is to be able to comment on the effectiveness of the systems that have been devised from a number of points of view. We consider the physical and software-based aids for navigation; the nature of the representation of architectural worlds; strengthening 'groundedness'; the inclusion of 'otherness'; and reinforcement of the idea of 'presence'

Introduction

Rendered building models tend to be very memory hungry and as a consequence interactive navigation around a rendered model puts considerable stress on the hardware used in the representation. However, it is not only real time animation that is the problem. If we are to move towards the idea of network or internet based collaborative design systems, then the memory problems referred to become exacerbated. In response, this paper describes a potential way forward in the development of techniques for producing architectural models that have both lower memory requirements and the capability of running in a common internet-based environment.

The work described here also leads to the development of alternative interfaces to Virtual Environments and suggests a reappraisal of some of the early work that allowed a sense of presence in the 'real' world. The phenomenon of sense of presence in virtual environments (VEs) is often seen as

the real essence of Virtual Reality [1] "*by changing space, by leaving the space of one's usual sensibilities, one enters into communication with a space that is psychically innovating…for we do not change place, we change our nature"[2]*

Much research has been carried out over the recent years into the interaction of the operator with a Virtual Environment (VE). The areas of interaction can be broadly broken down into the areas of interface, navigation and display and whilst there has been considerable work in the area of the design and navigation of the interface there is still considerable debate as to the best and most appropriate method(s) for interacting with the VE.

The 'traditional' method of interacting with the computer and a virtual environment is though the mouse, a method that the vast majority of users feel comfortable with in a 2-dimensional environment, but which leaves a lot to be desired when using a 3-dimensional world.

Early attempts at provided a sense of location with a VE were based on specific need of the military with flight and tank simulators, firstly with physical models and latterly with computer generated models. In these, the physicality of the immediate environment was an essential part of the experience. Whilst this was driven by the limitations of the then current hardware, it offers us some important lessons. Whilst the viewable area was limited by the power and screen resolution available, it was the familiarity of the immediate 'real' environment that overcame the lack of detail.

It is also worth re-evaluating some of the early scientific VE experiments where there could be no user-based reality, as the scale being modelled was at molecular level. Grope-III [3] was a developed to allow chemists to visualise the bonding patterns of complex molecules and 'feel' the bonding by means of feedback though the use of a remote manipulator arm . Even though this was patently an 'unreal' situation, the feedback felt through pressure on the hand was real. The method of navigation was through a natural analogy, in this case the hand which operated in a naturalistic way, the feedback giving the connection with the viewed scene.

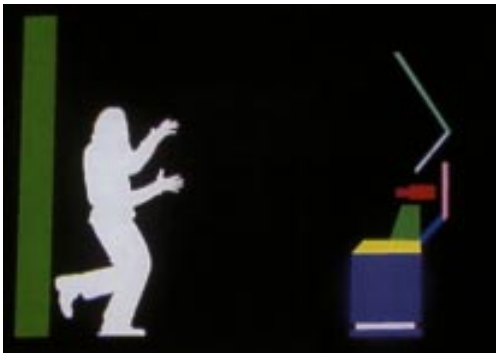

Figure 1
Video Place

In 'Video Place', Myron Kruger, an artist and computer scientist created an installation which, in one mode of operation, projected a shadow image of the participant onto a video screen which reacted to their movement. The specialised computing environment created by Kruger allowed the analysis of the participant down to the movement at finger level. A graphic object or 'critter' further interacted with this by attempting to climb over and follow the shadow. In this way the user had a sense of presence in the VE through the projected shadow and could directly interact with the VE. The shadow becomes an abstract form of avatar.

Early attempts at using a familiar and naturalistic interface were developed by AutoDesk [4]. Of these the second, the 'High Cycle' used a converted exercise bike to 'ride' through a virtual landscape (viewed through an early head-mounted display) and, if the user rode fast enough, take off and fly. Users reported that the familiarity of the interface allowed an easy assimilation of the experience, even it became 'unreal' as the participant flew over the landscape. The VE in itself was crude by today's

standards, but contained sufficient 'clues' for the participant to make the connection with a real landscape. The HMD was constructed from consumer mini TV screens and the signals sent through a thick and unwieldy umbilical cord from the two PCs (one for each eye image), but to an audience with lower expectations than today, it worked very well. The importance of a sense of orientation in a VE has been noted before [5]. In this case, the bike is fundamental in the realisation of this.

An important attempt at a non-realistic environment that used a 'natural' interface was 'Osmose' by Canadian artist Char Davies [6]. By using a navigational metaphor based on a scuba diving breathing technique, couples with an immersive headset projection, Davies allowed the users of the VE to navigate in a very simple, easily assimilated manner, quite literally as easily as breathing; breath in to move up, breathe out to go down. The ease with which users could learn the system was crucial to its success, even though the VE being experienced was totally unreal, the users felt a sense of belonging and connection, the ease of navigation being central to this. [7]

Figure 2
Osmose

Coupled with an increase in the power and availability of cheaper computers for home use has been arise in expectation of the quality of computer graphics, the majority of which has come through the demand of the gaming community. It is now recognised that games development is a major force. The rise in popularity of 'first-person' view, role playing games has risen out of this. These games (such as Quake and Half-Life) are virtual environments in the true definition of the term. Players have free movement and are often faced with foes that are programmed with a basic AI behavioural pattern. The development of these is aimed at achieving a 'realistic' environment at as higher resolution as possible and at as higher frame rate as current graphics cards will allow. The designers quickly realised that the sense of realism can be heightened by both lighting, atmospheric and sound affects that serve to give the user a sense of 'belonging' and presence in the VE. However, the controlling mechanism is still, for home use, the mouse or joystick.

Coupled with this has been the availability of software for users to create their own levels of the game. The architectectural contribution and content of the games can be recognised in the frequency of job adverts for games designers in the architectural press. In many cases the software used in the original game creation is the same as for many architectural simulations (e.g. Kinetix 3D Studio). Unfortunately, what is missing from many level editors is the ability to import 'standard' CAD or modelling data into them. This is due to the differ-

ent audiences that the software is targeted at, i.e. level editors at home users who cannot afford to spend £3500 on 3D Studio. Once this has been realised, the way will be open for architectural VEs to be quickly realised.

Proposal

It has been demonstrated that the method of interaction is a central part in the users immersive experience in a VE. Both the Legible City and Osmose used a consciously non-realistic environment through which the experience was heightened by the use of a naturalistic navigational metaphor. The importance of retaining a sense of orientation in a VE has been noted [8] and the problems of scaling and scalelessness [9] in the movement of a the navigation method.

What is proposed is the development of a generic navigational metaphor, adaptable to a variety of natural or naturalistic navigational methods. We have started to develop an architectural VE using a commercially available gaming engine and, initially, we propose to revisit the use of a bike for navigation.

The generic interface should also be adaptable for use with other, more narrow focus groups of users, obvious examples being a wheelchair and a treadmill. Whilst the wheelchair could not give an able bodied user a complete experience of being wheelchair bound, it would at least give an approximation of any potential problems. The physical effort involved in using either a bike, treadmill or wheelchair could also give a heightened sense of distance due to the effort involved in the navigation process, a problem noted by in large scale city environments [9], the sense of time (and more specifically, the passage of time) also being heightened.

An exercise bike [10] has been modified to give the basis of the system using a radically modified serial mouse. Left and right movement of the handlebars is translated into movement in the X axis, pedalling into the Y axis. Whilst this has overcome some of the problems some other researchers have found, e.g. the optical speed tracking of the wheel, it has raised others in the inflexibility of the scaling parameters of the standard mouse drivers. A purpose written driver will overcome this. The use of standard, modified components will allow us to apply the system to other types of natural interfaces such as walking (using a treadmill [11]) and disabled (using a wheelchair).

By revisiting the use of a naturalistic method such as the bike, and coupling it with games technology, the system will allow the exploration of an architectural virtual environment at relatively low cost. With the higher expectations of users today brought about by the widespread use of computer games, architectural visualisation and VEs must adapt and be flexible.

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Michael W. Knight, Andre G. P. Brown
School of Architecture and Building Engineering
The University of Liverpool, Liverpool L69 3BX
mknight@liv.ac.uk