NAVRGATE X, A NATURALISTIC NAVIGATION METAPHOR FOR LARGE SCALE VIRTUAL ENVIRONMENTS

MICHAEL W. KNIGHT AND ANDRE G.P.BROWN
CAAD Research Unit, School of Architecture and Building Engineering, The University of Liverpool, Liverpool L69 3BX, UK
mknight@liv.ac.uk, andygpb@liv.ac.uk

Abstract

This paper describes the latest in a series of real-world, low-cost interfaces for virtual reality. nAVRgate (the AVR being Architectural Virtual Reality) has looked at real-world analogies for interfacing with 'real' virtual environments in an attempt to improve the sense of presence, the phenomenon of sense of presence in virtual environments (VEs) often being seen as the real essence of Virtual Reality (Laurel, 1993)

keywords

Virtual Environment, Interface, presence

The original intention of the nAVRgate project (AVR being a sub-acronym for Architectural Virtual Reality) was to develop a low cost Virtual Environment where navigation was driven through natural locomotion, coupled with the possibility of an audience experiencing large scale urban environments.; that is with a large display area and wide angle of view. Two interesting projects that gave some early inspiration and direction: the "Legible City" (Shaw, 1990) and "Osmose" (Davies, 1996) projects. Both developed a body-driven navigation interface for the particular non-realistic environments (a text analogised city in the case of Shaw and a surrealistic environment for Davies). In the case of the Legible City, the interface was an exercise bike and for Osmose, a scuba diving metaphor was used. In both cases, users could almost immediately concentrate on experiencing the VE rather than learning the navigation method, that is the interface very quickly became transparent to them.

Just as importantly, the sense of presence and connection with the VE was very strong. (Davies, 1998). The aim of the nAVRgate project is the same rapid transparency and sense of presence. In this sense the work of others such as Regenbrecht et.al. (2000) also aims to move the developments in this area in a direction that will produce more effective and appropriate systems for navigation and interaction. It is, though, easy to fall into the trap of assuming that natural locomotion is best most appropriate for virtual environments. So far we have found it to be very effective, but are aware of the fact that assuming 'natural' is best may imply "questionable assumptions concerning distance and direction estimation and manoeuvrability" (Darken et.al. 1998).

The importance of presence to the success of architectural virtual environments is an important discussion. Should architectural VEs strive to be hyper-real (with all the attendant hardware issues of manipulating large amounts of data in real-time) or does a degree of abstraction in representation still afford an acceptable degree of presence?

Presence has been defined as "the observers subjective sensation to 'being there' in a remote environment" (Freeman, Avons, Perason and Ijsselsteijn, 1999) and "the subjective experience of being in one place or environment, even when one is physically situated in another" (Witmer and Singer, 1998). For a successful sensation of presence, two factors must combine, that of involvement and immersion. Involvement is experienced "as a consequence of focusing ones energy on a coherent set of stimuli" and immersion as "perceiving ones self to be enveloped by, included in, and interacting with an environment that provides a continuous stream of stimuli and experiences" (Witmer and Singer, 1998).

For virtual reality to work it must be possible to overlay sensory information derived from interacting with the environment onto the normal proprioceptive channels. These have been defined as"...that continuous but unconscious sensory flow from the movable parts of our body (muscles, tendons, joint), by which their position and tone and motion is continually monitored and adjusted, but in a way which is hidden from us because it is automatic and unconscious" (Sacks, 1985). Proprioception allows us to construct a mental model of our body for any given situation and the disposition of its limbs. Taking this argument further, the type of interface that is employed in a VE can increase the ‘naturalness’ of an experience by grounding the user in the familiar, that is allowing the interface to reinforce the proprioceptive signals that the user would have experienced in reality.

With a large scale urban VE, navigation methods such as flying are useful in the appreciation of the macro scale, but do little to engage the lay viewer with a scale that can be easily related to. If the naturalistic metaphor is taken to a logical conclusion, differing interfaces would be required for differing tasks, for example moving relatively large distances between buildings would be a an 'assisted' task (using a mechanical device such as a bike) as opposed to moving around a building for which a bike would be unsuitable. Whilst our aim is to develop an integrated set of interfaces which allow for navigation appropriate for different task, this curent phase of nAVRgate further develops an interface for the large scale.

The first interface developed used an adapted exercise bike which was successful as a interface and used a game level editor for creating the 'world'. Problems arose from the inflexibility of the game platform and a lack of portability. (Knight and Brown, 1999). The second interface builds on previous experiences and concentrates on external navigation, in this case a partial city model. The system is in two parts, the first is the use of a commercial gaming engine for the development of the virtual world. This gives the requisite level of control over the various separate control elements of the physical interface. The second part is the physical interface itself. The use of a commercial game engine afforded us many advantages and a not inconsiderable number of difficulties. The bike interface used a customised game which allowed for limited changes, and as such was restrictive, but did allow a proof of concept. The full game creation system allows virtually unlimited flexibility at the expense of greatly increased development time. The flexibility did allow us to remove some of the unnatural constraints forced upon us by the lack of flexibility of the original game.

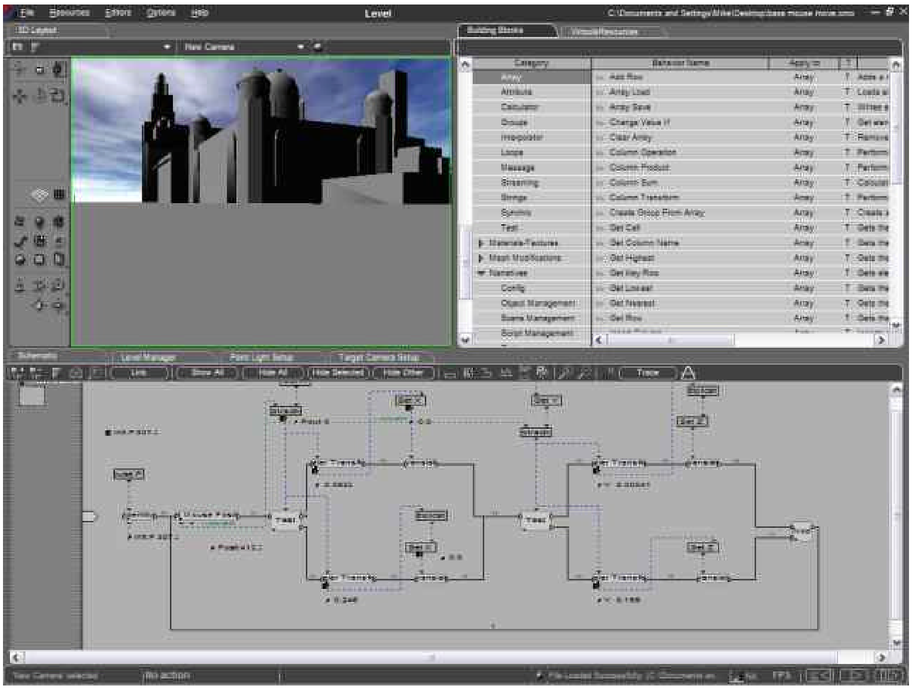

Figure 1 The game authoring environment

Geometry is imported into the system from a CAD package where physical attributes are added along with the behavioural characteristics for the user. The system uses schematics to allow visual programming of the world, mapping the positive and negative X axis movements from Left and right movements of the handlebars and positive and negative Y axis movements from the forwards and back movements of the foot operated roller. One of the main problems with the original bike interface was the lack of scaling available which lead to exaggerated movements of the handlebars which detracted from the overall experience (Knight and Brown, 2000). Our current software will allow us to more fully develop the navigational clues and suggestions which will aid successful navigation. Positional sound, on-demand location maps and links to contextual, external information will be investigated during the next phase of the work.

The physical interface has been designed to be portable, the portability parameters being defined as being able to be carried as aircraft hand baggage. Continuing the theme of the previous interface, an urban scooter has been converted using a combination of mouse and joystick interfaces. The scooter is able to be dismantled into an aluminium carry case which conforms to the minimum dimensions of aircraft hand luggage. Assembly follows the normal scooter assembly with the handlebars being inserted into the shaft and raised to a vertical position. Of course the ground and scooter movement is reversed, the ground being replaced by a movable belt and the scooter being stationary. In addition to the expected forwards/backwards/left/right movements, there are three additional controls, these being look up, look down and a virtual 'pogo stick' (the former is a temporary measure until a more natural head movement method can be developed). The virtual pogo stick allows the user to spring up vertically from their current position and regain their bearings when they become 'lost'. Portability became an issue with the bike interface during its use. Indeed with the current system, a laptop, the relatively small, light case of the scooter plus a small data projector is the system and it is entirely conceivable that a dedicated computer could be built into the case, further increasing portability.

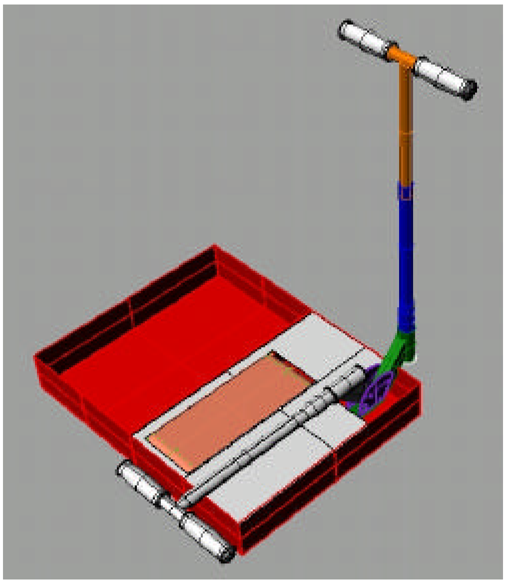

Figure 2 the scooter interface

The model used was of our University campus. We selected groups for feedback testing that had differing degrees of familiarity with the campus differing degrees of experience of virtual environments and differing levels of architectural education. The users were asked to visit two buildings on the campus and assess their experience by questionnaire. Additionally, a video record was made for later analysis.

Parallel work by the authors on perception of the rendered image has had a direct impact on the nature of the large scale VE used for testing the new interface. Reassessing the degree of detail required has enabled the model to be both recognisable computationally efficient. For reasons of economy of effort, a small area of the model was chosen for further detail development. Five versions at varying levels of detail were developed and these formed the basis of user testing. The level of detail varies from a basic massing model (high frame rate/low recognition) to a full detailed model (low frame rate/high recognition). We were interested to determine the optimum compromise between a usable responsive model and giving sufficient detail to be recognisable.

Analysis of initial experiences of user testing are still ongoing at the time of writing, but initial analysis shows results comparable to previous work. In this evaluation we are aware of the fact that assuming that 'natural' is best may imply "questionable assumptions concerning distance and direction estimation and manoeuvrability" (Darken et.al. 1998). With both nAVRgate 1 (the bike) and this latest phase (the scooter), we found that a wholly naturalistic paradigm was indeed appropriate and gave a heightened sense of presence and involvement in an environment.

References

Bridges, A and Charitos, D 1997, *The Architectural Design of Virtual Environments*, CAAD Futures 1997 München (Germany), pp. 719-732

Davies,C. 1998, *Changing Space, Virtual Reality as an Arena for Embodied Being in The Virtual Dimension,* Architecture, Representation and Crash Culture, ed. J Beckmann,

Davies, C. 1996, *The Paradox of Being in Immersive Virtual Space*, SIGGRAPH 96 panel, Soul in the Machine, The Search for Spirituality in Cyberspace,

Knight,MW and Brown, AGP 1999 *Working in Virtual Environments through appropriate Physical Interfaces*, Architectural Computing from Turing to 2000 Proceedings of eCAADe 17 Liverpool (UK), pp431-436

Loomis, J.M., Da Silva, J.A. Fujita, N. and Fukusima, S.S. 1992, *Visual Space Perception and Visually Directed Action*, Journal of Experimental Psychology: Human Perception and Performance, 18(4), pp. 906-921.

Slater M, Usoh M, Steed A 1994 *Depth of Presence in Immersive Virtual Environments,* Presence: Teleoperators and Virtual Environments, MIT Press 3(2), 130-144.