Bike-R: Virtual Reality for the financially challenged

Jules Moloney

This paper describes a 'low tech' approach to producing interactive virtual environments for the evaluation of design proposals. The aim was to produce a low cost alternative to such expensive installations as CAVE virtual reality systems. The system utilises a library of pre-rendered animation, video and audio files and hence is not reliant on powerful hardware to produce real time simulation. The participant sits astride a bicycle exercise machine and animation is triggered by the pedal revolution. Navigation is achieved by steering along and around the streets of the animated design. This project builds on the work of Desmond Hii. (Hii, 1997) The innovations are the bicycle interface and the application to urban scale simulation.

Keywords*: virtual, design, interface, urban.*

Introduction

The Bike-R project is part of a wider study of the impact of digital technology on the design studio in architectural education which on going at the University of Auckland. The aim is to apply available low cost technology to design studio teaching. The primary strategy developed at Auckland has been the implementation of Computer Aided Studio (CAS) where the emphasis was on the integration of digital and traditional media. In our view the physical and pedagogic integration within the design studios is crucial to the effective use of the computer as a design aid.

Consequently when considering virtual reality systems we rejected the purchase of head mounted displays or screen based systems. The cost and 'fragility' of such systems would inevitably mean they would at best become isolated areas of interest with little impact on the general design studio. Furthermore we have found that mainstream CAD packages such as ArchiCAD and 3D Studio MAX have developed interfaces that offer sufficient real time manipulation to meet the needs of students "understanding spaces whilst in the design process" (Bourdakis, 1998). In our view such interfaces offer sufficient simulation for the sort of 'block modeling' and evaluation that we encourage at the early stages of design. However while these real time interfaces are adequate for the process stage we found students were frustrated when attempting to present a high level of detail and realism during final crits. The problem was most acute when students attempted to animate complex urban scenes. Bike-R is an attempt to provide a low cost and robust means of simulating such complex models for final presentation and evaluation in the architecture design studio. Our aim is to allow students to investigate and present aspects of movement in relation to architecture and urban design.

Mobile Subject / Deforming Object (architecture)

It is self evident (but under utilised) that architecture is experienced by bodies in a state of perpetual motion - actual body movement and / or through oscillating observation. However the means by which we conceive, evaluate and critique architectural proposals are still dominated by standard orthographic projections - supplemented by models at a scale that reinforce object qualities, or the now obligatory computer *fly* through. The development of virtual environments such as CAVE has offered the tantilising prospect of developing architecture from the point of view of a roving inhabitant. (Unfortunately the cost precludes use of such virtual reality systems within most schools of architecture.) Less self evident than the roving eye of the viewer is the potential of architecture itself to deform through movement of body parts / skin or to be transformed visually through the oscillation of the territory occupied. Obvious examples are windows and doors or the transformation of surface under different light conditions.

The Bike-R project is an attempt to address both the mobile subject and the deforming object. The aim was to enable users to pedal down a virtual street and evaluate the student projects within a dynamic context. There were three stages involved in the project.

Stage 1 Composite site video and animation

We anticipated two main benefits from using actual site video as opposed to animating a digital site model.

(a) Time efficiencies: Compared to 3d modeling, digitizing analogue video is a very effort and time-efficient procedure to reproduce complex geometry and such urban phenomena as wind through trees, cars and pedestrians.

(b) Realism: Form, colour, sound, movements and other behaviors of the physical environment are recorded in a very close manner to how they are actually perceived.

However the requirements for the site video turned out to be more complex than anticipated. The more ‘real’ the site footage the more likely the problems later when compositing the digital buildings. Changes in atmospheric conditions - sunlight intensity, shadows, etc. - and the appearance of foreground objects and events were to cause significant complications. We are currently pursuing two strategies. The first is a tactical move to record low grade site video and use video editing filters to add similar ‘noise’ to the computer animation. The objective is to deliberately lower the expectations of the user so that discontinuities are overlooked. This would be more suitable for evaluation prior to attempting more detailed simulation or for students who wanted a more ‘conceptual’ presentation. The second strategy is to record relatively high resolution video and attempt to solve problems associated with high realism. The major problems relate to disparities in lighting and embedding foreground objects. These problems can be addressed using techniques of superimposition established in the film industry but they are time consuming and work against our aim to make Bike-R a widely used studio resource.(Vaz and Dunignan, 1996) We are hoping this may be addressed as more composite videos are produced and sections of previous video can be reused. The aim would be for these to be used as ‘library parts’ in subsequent videos.

Most of the video to date has been recorded with a Sony handycam with a steadyshot movement compensator. This was attached to the front of a vehicle travelling in as regular a path as possible and at a constant speed of 25 kph. After recording the video, site measurements were taken to locate key objects which could be used as ‘ camera trackers’ when compositing the site and digital models. The video was digitised using a low cost video capture card. This was then imported into 3D Studio Max as the background to the digital model. The camera tracker utility was used to match the motion of the digital camera with the real camera and after experimenting with lighting effects a composite video was produced. This was subsequently exported to

Adobe premiere where filters were used to ‘blur’ the edges between digital building and site video. The initial attempts at producing the composite were time consuming and the results disappointing in terms of a seamless integration of the digital model and the site. However once a working method was established we believe we have achieved the anticipated benefits of time efficiency and ‘quasi realism’ .

Stage 2 Interactivity

We have used Lingo scripting within Macromedia Director to provide interactivity. The speed of digital video can be altered using the frame rate command. Frame dropping becomes extreme on speed increase hence the decision to record the video at an average bicycle speed and slow down the frame rate. Segments of video can be linked together and the user can choose ‘paths’ to explore a network of composite video streets. All events are triggered by ‘keyDown’ events to enable students to prepare and test their urban scenes on a standard keyboard / screen interface.

For students wishing to achieve a greater sense of interactivity we have developed a method to simulate head movement. For these projects video is recorded with a wide angle lenses which is digitised at high resolution. Within Director a foreground layer is introduced to frame a portion of the video. The video can be manipulated behind the masking frame in response to mouse movement. The effect gives a sense of real time movement of the camera position.

Stage 3 The bicycle interface

An old bicycle was salvaged and bolted to a robust stand which suspended the back wheel above the base by 50 mm. A light sensor reacts to the rotation of the wheel and as the user increases the wheel speed the number of interrupts can be measured. Frequencies are set to relate to a range of speeds and as these thresholds are reached ‘keyDown’ events are triggered by direct wiring to an old keyboard. In another ‘low low’ tech move a infra red mouse is attached to a bicycle helmet to allow head movement interaction as described above. A high end pentium computer is connected to a data projector which is placed above and behind the user. The shadow of the user’s head appears at the bottom of the screen to further enhance the sense of interaction with the composite street

User Feedback and Further work

Preliminary feedback from users at this prototype stage is positive. It would appear natural body movement (cycling) unencumbered with head mounted displays or body suits facilitates a high degree of immersion. In addition the audience can share the ‘experience’ which makes the interface ideal for the context of a design studio crit.

Bike-R is at an early stage of development and further refinement of the basic technique outlined above can be anticipated. In addition to refinement we are planning to supplement the composite video with QTVR. The intention is to allow the user to stop at various points along the composite street. At these nodes the system will switch to QTVR and allow 360 degree navigation via the ‘helmet mouse’. A further enhancement is planned to allow the real time evaluation of architecture interiors. We intend to use a sophisticated computer game interface which allow photorealistic textures and volumetric lighting for a limited number of polygons.

References

V. Bourdakis, Virtual Reality in Teaching Architecture.(http://fos.bath.ac.uk/vas/papers/VR_in_HigherEducation.html)

D. Hii, Hands-Free Image based VR System for the masses - Virtual Museum in: Proceedings of the ACM Symposium on Virtual Reality Software and Technology, Hong Kong, 1996

M Vaz and P. Dunignan, Industrial Light and Magic: Into the Digital Realm (Ballantine Books, New York, 1996)

Jules Moloney
Department of Architecture
University of Aukland, NZ
j.moloney@auckland.ac.nz