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Original Citation

Gibson, Ian and England, Richard (2004) Fragmentary Collaboration in a Virtual World: The Educational Possibilities of Multi-user, Three-Dimensional Worlds. In: Advances in E-engineering and Digital Enterprise Technology-1: Proceedings of the Fourth International Conference on E-Engineering and Digital Enterprise Technology (e-ENGDET), Leeds Metropolitan University, UK, 1-3 September 2004. John Wiley and Sons, London, UK, pp. 299-304. ISBN 9781860584671

Fragmentary Collaboration in a Virtual World: The Educational Possibilities of Multi-user, Three-Dimensional Worlds

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ABSTRACT

This paper discusses research into online, multi-user, interactive virtual worlds for use in education. A 3D virtual gallery with a shared whiteboard has been developed using several multimedia software packages. The results show that it is possible to create effective, intuitive virtual environments in which users may interact, communicate and collaborate with projects. Technical, social and pedagogical issues are discussed. Further work will be directed towards exploring applications for this environment.

1 INTRODUCTION

The three-dimensional virtual world is an emerging medium that offers the communication opportunities of a text-based environment with a visual representation of space for users to interact within. They also pose a number of questions. How technically feasible is it to create a multi-user 3D space? How is the user constructed in that space? Do these worlds allow for new methods of communication, learning and collaborative working?

As there is little existing research specifically in the area of multi-user 3D worlds, a large part of the research described in this paper is derived from data collected through observations and interviews. The research explores the design features that serve to represent the user in the world. Popular virtual world software packages have been used, namely Active Worlds and Adobe Atmosphere. The project's objective is, in the first instance, to develop a three-dimensional, multi-user collaborative world.

2 BACKGROUND

Shared 3D worlds are a relatively recent development. Therefore it is hard to find specific and readily available research into their educational use (1). However, much can be gleaned from research based on two-dimensional text based environments (2), such as UseNET and other applications featuring visual chat interfaces with 2D avatars (The Habbo Hotel, for example).

Research into the roots and social issues associated with virtual worlds and communities is comprehensive. Issues arising include fragmentation (3), the process of creativity and 'collective' collaboration (4), reality and simulation (5) and the construction of the 'self' (6). These subjects are referred to in this paper but are not discussed at length.

3 TOOLS USED IN THE CREATION OF A VIRTUAL COMMUNITY

The list of tools which were used to create and supply the virtual community is extensive. It includes software for a robust client-server architecture (Flash Communication Server), dynamic generation and streaming of 3D object-models, latency handling and video/audio streaming.

Macromedia Flash (available to a large number of users) provides dynamic content and an object oriented programming language. It was used to create the whiteboard as an 'intelligent' texture. 3D Studio Max and Bryce were used for 3D model and texture generation, the former used specifically to generate 'cubic' background textures and landscapes. Director/Shockwave was incorporated into the system since it is currently the only web-3D engine supporting dynamic textures via Flash.

4 AIMS AND OBJECTIVES

As this was an experiment to develop shared virtual spaces in an educational environment, the first step was to create a shared space. The objectives were:

1) To investigate user interaction using a virtual whiteboard.
2) To develop methods of communication either via text-based chat or via audio-visual communications.
3) To investigate ways of creating *immersion* in a three-dimensional space.
4) To identify innovative communication methods.
5) To consider the demand for virtual worlds in education.
6) To investigate the learning potential of a virtual world.
7) To look at the costs involved in the creation of a virtual space.
8) To investigate the technical and social limitations of a virtual 3D space.
9) To explore the potential of real world models in a virtual world.
10) To explore issues relating to communication bandwidth limitations.

5 SYSTEM DEVELOPMENT

A series of experiments was produced. Each experiment was designed to incorporate the ideas of social interaction and a sense of community via shared items and experiences. Multi-user environments were investigated utilizing object oriented programming languages to create shared objects and stream data. In addition, fast and efficient ways of generating 3D models in Lingo were developed.

Shared objects and data streams were stored and processed, server-side, by Flash Communication Server. Client applications connected to the server application via a network connection object. Any change to a shared object, either client or server side, initiated a synchronisation command to all connected clients. This provided a means of real-time collaboration and communication between many users.

A webcam video-stream rendered as a 3D texture provided a visual construction of the 'self' and an audio contact. The video texture concept was expanded using scripted (Flash) applications as textures (a whiteboard), thereby creating an interactive texture. The prototype system is shown in Figure 1.

Figure 1 Screenshot of the prototype system

3D visualisation was achieved through modelling techniques in 3D Studio Max and Bryce (for a QTVR style cubic skybox). In addition 'burnt' textures were generated, producing an atmospheric environment.

6 PROBLEMS AND RESTRICTIONS

Bandwidth capacity was a limiting factor of this system, and was eased by the streaming features of Flash. Other client-side hardware restrictions were overcome by creating efficient Lingo generated 3D images (which required less loading and processing time) and the use of a 2D portal. Figure 2 illustrates the connection of 2D and 3D portals through the server architecture. Maintaining 'intelligent' textures was also found to be CPU intensive. However, a synchronisation command was used to resolve performance issues by updating images only when necessary.

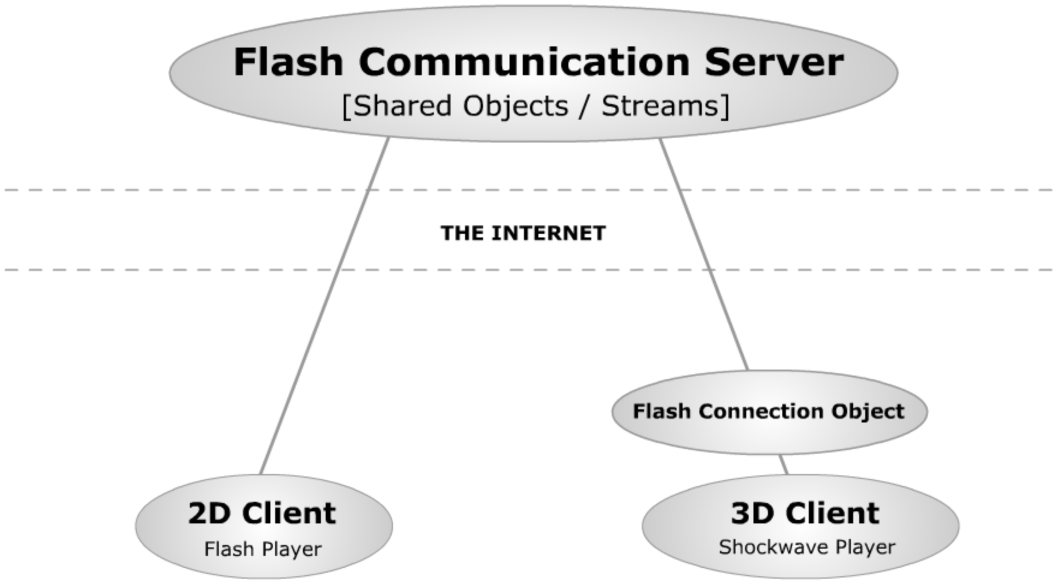

Figure 2 The system architecture permits communication between any combination of 3D and 2D portals

File size issues also needed to be considered. By streaming images after the initial download, avoiding over-complex models and utilising Lingo-generated 3D images, initial file download times were reduced. On the server side, multiprocessors acted as a solution to scalability concerns (7).

Educational institutions are subject to bureaucracy in the form of network and installation limitations. Common plug-ins (e.g. Flash and Shockwave) and HTTP 'tunnelling' features are a partial solution to these limitations because they are widely accessible to users.

Applications (such as 'Atmosphere') allow user-specific virtual worlds to be built quickly and cost effectively by using existing models as templates. It is important that such a feature is made available in any competing product. The experimental shared objects provide a potential for many users to develop a 3D world collaboratively, thereby reducing development time. However, the method of creation needs to be addressed.

7 ANALYSIS OF THE SYSTEM

The system incorporated the following features: a merging of 2D interactivity with 3D engagement, collision detection, first/third-person viewpoints and real-world models. It must be noted, however, that most 'real-world' settings did not offer enough potential for interaction or crowded areas. This is offset by the fact that many objects on-screen were found to reduce the frame rate.

Methods of control were based upon the well-known features of QTVR, such as a changeable focal length, 'hotspots' and mouse control. A graphical two-dimensional world was proven to work (albeit with limited immersion) as an alternative route to the same community features.

Real-time communication, produced via a microphone and web-cam, provided human interaction in 3D. A textual chat facility was also incorporated. Such real-time verbal and non-verbal communication allows for a greater degree of emotional engagement and *immersion*, which is not the result of sensorial input, but the result of humans interacting with one another in an environment (8).

Learning is viewed as a social activity. To that end the system provided communication and collaboration with an identity. Engagement, both among participants and with environments, is important for any educational medium.

In essence the system is an assimilation of QTVR engagement with 3D benefits. A content rich environment offers interactivity with other media such as web sites, while multi-user shared objects provide a constructive approach to interaction. As an instrument of public relations, a common problem of document-based websites is the very lack of such interaction. Virtual worlds can offer potential students information, combined with fun, chat and exploration. They can be a promotional tool combating the elitist metaphors usually associated with higher education. Additionally, a generation of students have been brought up with games (such as Doom). It is this generation that is most likely to relate to software environments with the metaphor of a place as opposed to those with a more conventional interface.

8 CONCLUSIONS

The following conclusions were reached:

1) Shared objects provide potential for online collaboration in a virtual space.
2) Audio, visual and text-based communications are all viable possibilities with this medium.
3) Worlds should be constantly changing and changeable, i.e. interaction is the key to immersion.
4) Real time video communication does not currently exist in the market for multi-user 3D worlds. Therefore this is an innovative feature of this system.
5) A generation of students brought up on games and environments that stress navigation through 3D spaces demands a virtual world that is built around the metaphor of a place.
6) In an educational establishment, a virtual world could be used as a way of promoting facilities.
7) It is possible to produce virtual worlds cost effectively.
8) Overbuilding creates a slow frame rate while large spaces offer less stimulation. A rich variety of objects close at hand (in a smaller world) are preferable.
9) Very few real world models are worth emulating in a virtual world, the most suitable being places designed for dense crowding and interaction.
10) Communication in a virtual world does not require a high bandwidth.

9 FUTURE RESEARCH

Issues to be investigated further include user authentication, ‘crowd control’, positional sound, management of objects/users via databases, and the dynamic building of user-made worlds. Importantly, further applications of 3D virtual worlds need to be explored.

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