Emerging Applications in Immersive Technologies

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INTRODUCTION

The world of Virtual Environments and Immersive Technologies (Sutherland, 1965) (Kalawsky, 1993) are evolving quite rapidly. As the range and complexity of applications increases, so does the requirement for intelligent interaction. The now relatively simple environments of the OZ project (Bates, Loyall & Reilly, 1992) have been superseded by Virtual Theatres (Doyle & Hayes-Roth, 1997) (Giannachi, 2004), Tactical Combat Air (Jones, Tambe, Laird & Rosenbloom, 1993) training prototypes and Air Flight Control Simulators (Wangermann & Stengel, 1998).

This article presents a brief summary of present and future technologies and emerging applications that require the use of AI expertise in the area of immersive technologies and virtual environments. The applications are placed within a context of prior research projects.

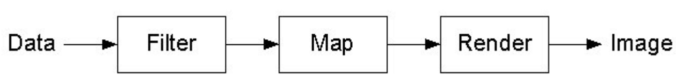
BACKGROUND

Visualisation is defined as the use of computer-based, interactive visual representations of data to amplify cognition. The much cited process driven visualisation pipeline proposed by Upson et al (1989) is shown in Figure 1. Upson and his colleagues define three processes consisting of filtering, mapping and rendering the data. The image presented allows the user to draw some inference and gain insight into the data.

The *Filter* process is when data of interest are derived from the raw input data; for example, an interpolation of scattered data onto a regular grid. This data is then *Mapped* into geometric primitives that can be then be *Rendered* and displayed as an image to the user. The user may then gain an improved understanding and greater insight into the original raw data. The type of data and application area heavily influence the nature of the mapping process. That is, choosing the actual visualisation technique that we are going to use. For example, if the data consisted of 1D scalar data, then a simple line graph can be used to represent the data. If the filtered data consists of 3D scalar data, then some form of 3D isosurfaces or direct volume rendering technique would be more appropriate. Through the various specifications and conceptualisations of the filter-map pipeline above, we would propose an ontology that describes the relationships between data type and mapping processes that facilitates the automatic selection of visualisation techniques based on the raw data type. As the applications become more sophisticated the visualisation process can make use of the data ontology to drive AI controlled characters and agents appropriate for the application and data.

A starting place for this can be seen in the area of believable agents (Bates, Loyall & Reilly, 1992) where the research ranges from animation issues to models of emotion and cognition, annotated environments. Innovative learning environments and Animated Pedagogical Agents (Johnson, Rickel & Lester, 2000) provide further areas for development, as do industrial

Figure 1. Upson et al's visualisation pipeline



applications, for example Computer Numerical Control (CNC) milling operations virtual training prototype system (Lina, Yeb, Duffy & Suc, 2002). Teaching environments using multiple interface devices in virtual reality include Steve (Soar Training Expert for Virtual Environments) that supports the learning process (Rickel & Johnson, 1999) with collaborators including Lockheed Martin AI Center. SOAR (Laird, Hucka & Huffman, 1991) has also been used for training simulation in air combat (TacAir-Soar) (Jones, Tambe, Laird & Rosenbloom, 1993). This autonomous system for modelling the tactical air domain brings together areas of AI research covering cognitive architectures Human Behavior Representation (HBR) / Computer Generated Forces (CGF). SOF-Soar: (Special Operations Forces Modeling) (Tambe, Johnson, Jones, Koss, Laird, Rosenbloom and Schwamb, 1995) uses the same underlying framework and methods for behavior generation based on the Soar model of human cognition, each entity is capable of autonomous, goal-directed decision-making, planning, and reactive, real-time behavior. As the world of digital media expands emerging applications will draw on the worlds of Virtual Theatres (Giannachi, 2004), interactive storyline games and others forms of entertainment (Wardrip-Fruin & Harrigan, 2004) to enhance the visualisation experience, especially where virtual worlds involving human artifacts and past and current civilisations are involved.

SWARM INTELLIGENCE FOR VISUALISATION

Understanding the behaviour of biological agents in their natural environment is of great importance to ethologists and biologists. Where these creatures move in large numbers is a challenge for orthodox visualisation.

Working with marine biologists, a 3D model of large numbers of swarming krill (Figure 2) has been created. The model augments the classic swarming functions of separation, alignment and cohesion outlined by Reynolds (1987). The generated 3D model allows cameras to be placed on individual krill in order to generate an in-swarm perspective. New research on Antarctic krill (Tarling & Johnson, 2006) reveals that they absorb and transfer more carbon from the Earth's surface than was previously understood. Scientists from the British Antarctic Survey (BAS) and Scarborough Centre of Coastal Studies at the University of Hull discovered that rather than doing so once per 24 hours, Antarctic krill 'parachute' from the ocean surface to deeper layers several times during the night. In the process they inject more carbon into the deep sea when they excrete their waste than had previously been understood. Our objective has been to provide marine biologists with a visualisation and statistical tool that permits them to change a number of parameters within the krill marine environment and examine the effects of those changes over time. The software can also be used as a teaching tool for the classroom at varying academic levels.

Figure 2. 3D krill and sample 3D swarm

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