Position Paper: Agents and Activities in the Intelligent Virtual Environment *Brightown*.

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Abstract

This position paper considers the varying applications within intelligent virtual worlds for which the illusion of intelligence should be maintained without introducing expectations beyond the systems abilities. A set of applications is identified where control should be passed from autonomous avatars to a human control operator in some interaction intensive situations in order to provide sufficient functionality and response to maintain both engagement and presence.

1. Introduction

This workshop position paper considers "How should users control the intelligence in intelligent virtual environments (IVE)?".

Most people regard only humans as intelligent, and will not accept that it can be attributed to other living species, or man made artifacts. Therefore if intelligence exists in an IVE which simulates the world it will either be evident, and included in simulated humans, or concealed, and used to simulate artifacts which are part of complex systems in the real world (e.g. cars, water flow etc..). This second class will not be considered further since the use of symbolic modelling, reactive planning, and other AI techniques to simulate artifacts will either succeed and produce artifacts which users interact with as though they were the real thing, or fail and introduce conventional interactions as yet unspecified.

If the IVE includes artifacts which do not simulate reality, then any notion of intelligence can be introduced, according to any new conventions, as long as intelligence can be attributed to it. On first consideration this class may seem similarly dismissable as the last since it is based on establishing conventions, however, one extras condition applies here: that the conventions of interaction support the attribution of intelligence to the artifact. Again, since the only item to which we attribute intelligence is the human, the interaction techniques for this class should reflect those of humans enough to support this attribution. Therefore we need to consider how to interact with the intelligence of human, or human-like artifacts in IVE's, or more precisely, avatars of humans.

2 Interacting with Autonomous Avatars.

It would be nice to assume some general purpose intelligent agent like Arthur C Clarke's HAL 9000 in 2001, perhaps using reactive planning drawing on the Cyc general knowledge base, through an intelligent multimedia control pipeline such as the IMMPS RM (Bordegoni et al, 1996) to a human avatar conforming to the proposed MPEG 4 Human Architecture (VHAG, 1998). Unfortunately the technical limitations which prevent such a system are well documented (e.g. Stork, 1996).

In the absence of HAL 9000 we must produce specific purpose intelligent agents with sufficient human-like realisations to support the attribution of intelligence, but without raising expectation to those of general purpose human abilities.

Conventionally HCI analyses of user behaviour to which interface design has been matched have used the task goal as the top level of analysis, and assumed goal based behaviour for most activities. Following this convention, the specific purpose chosen for each interface would be a user task. However, other activities have been suggested to take place in multi-user virtual worlds (MUVW) which are not explicitly task oriented. Table 1 presents some example agent roles proposed for MUVW.

Example Actors

Character	**Environment**	**Aim**	**Author**
dog	desktop	WWW information retrieval	http://www.agentware.com/
human bar staff	bar	console/amuse customers	http://www.extempo.com/
mentor - human or invented character	information space	to guide a pupil through a new knowledge domain using general skills but without explicit knowledge of that domain	Barbara Hayes-Roth, Stanford Univ.
male or female	bedroom	sexual fantasy	
human terrorists	house	training to cope with terrorist kidnapping situation	Http://www.sandia.gov/vris/VRaptor.html
human	WWW page	explain information	http://www.dfki.uni-sb.de/imedia/ppp/

bugs	Starship Troopers Game world	to have fun & thrills	http://sonypic.com/vs/
worm	information space	pedegogical instruction of student	Carolina Univ.

Several of these applications are oriented towards the maintenance of emotional states of pleasure, reassurance, or other emotions in the user. Therefore, modelling should start above the goal, at the emotional level. Andrew Ortony (et al, 1988) has proposed a cognitive theory of emotions which has been mapped to goal level operations so that the emotions result in both goals, and constraints on the later processing of goals. Such modelling, in conjunction with pure goal level modelling is appropriate for the IVE as suggested at the 1997 Workshop on Animation at the User Interface at IJCAI in Nagoya, Japan. Below this level, control of the avatar can follow an established architecture such as the Intelligent Multi-Media Presentation System Reference Model (Bordegoni et al, 1996) which includes models of domain, task, users, & dialogue. Actors in the IVE can be rich in these to differing proportions according to their aims shown in Table 1.

If the automated avatar uses a dialogue interface with user avatars, then it will evidently be limited in its language skills (). Therefore a controlling operator will have to take control of the automated avatar when advanced language dialogue is required. Therefore two user interfaces exist for these automated avatars, one for the controlling operator, and the other for the users of the environment through their own avatars. The avatar interface should be as consistent with human intelligent behaviour and dialogue as possible, but it should also include error or situation detection to identify when it will be required to operate beyond its automated abilities. Once it has identified that such a situation exists, it will be necessary to notify the control operator and pass control to him until the situation changes. This approach generally should overcome problems of believability for agents in IVE, however there is considerable cost in using a control operator.

The use of control operators in this situation has been demonstrated at Sandia National Labs work on intelligent battlefield simulation, and on simulation for training against terrorist kidnapping by Stansfield & Shawver (1996). The simple test in this situation has been whether a user avatar is directly addressing dialogue to the automated avatar. When this does not happen, simple reactive plan inclusive scripts can be used to guide the automated avatar through the environment. When dialogue is addressed to them they notify the control operator, and pass control through a control menu to him. Once this situation changes the control operator re-loads the automated control script, setting its starting parameters, and the automated phase starts again.

The interesting research issues in this approach relate to :

1) How does the automated avatar identify situations when control should be handed to a human? The simple case of direct dialogue with users may be one but it is not sufficient; for example, can complexity limitations in behaviour due to real time constraints on planning cause a handover ?

2) What should the interface tell the control operator to make the handover maximally efficient? This requires a representation of the state of the automated avatar in the situation.

3) What should the control interface be for the user - at this point a direct manipulation interface appears to be required. This necessitates the combination of direct manipulation and command style interfaces as proposed by Ed Hutchins at the 1986 Venaco Workshop on Multimodal Dialogue. His model supports a consistent user model, but it needs populating with an appropriate situation description. This approach generally resolves apparent conflicts between Direct Manipulation and an IVE.

4) What should the control interface be to pass control back to the automated avatar ? In principle this is a conventional delegation task, as found in many information retrival type intelligent agents. Analyses of interface design and animation for delegated tasks (Wilson, 1997) has shown the main structure of this. However, again this needs populating for the situation.

3 The TestBed

We are developing a test interface for autonomous avatars which can be taken over by human control when the interaction required by a user is beyond their autonomous capabilities. This follows the style of Stansfield & Shawver (1996), for a training application, where the trainees are potential nuclear emergency control officers in a nuclear accident at one of our laboratories nuclear facilities.

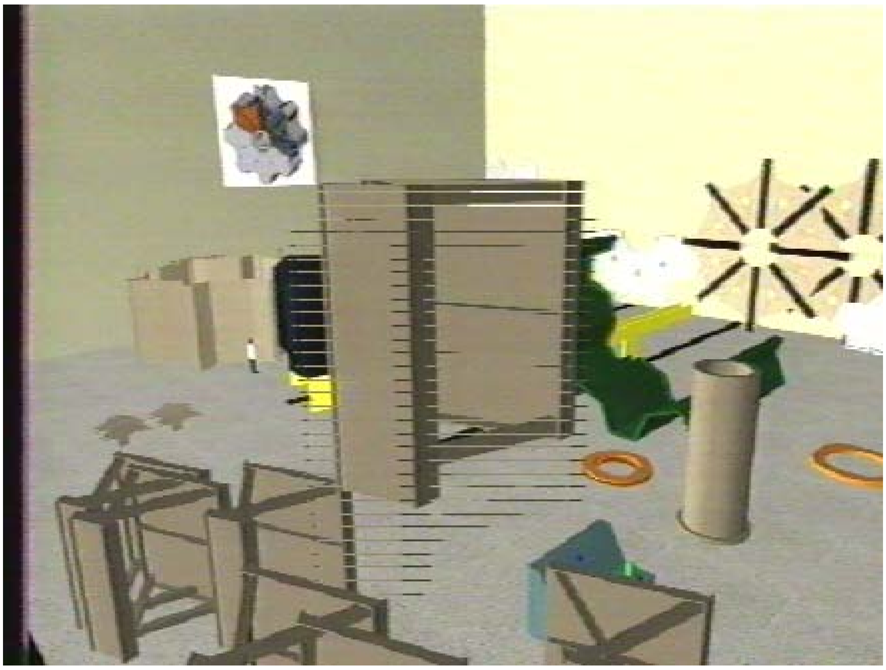

Figure 1: A view of the VR model of high energy physics detector equipment in the assembly hall.

The scenario is one where an emergency has been declared, the trainee must undertake various procedures to determine the cause of the emergency, and to ensure that no human life is put at risk. Autonomous avatars are used represent the panic stricken mass of personnel in the laboratory who are running to emergency exists from the immediate area, whilst trying not to leave buildings and contaminate the atmosphere with fallout.

Such training is undertaken once every five years using real humans, but this requires the cooperation of all laboratory staff, local emergency services, and the local population for a radius of five miles around the laboratory. Understandably this requires considerable cost, and simulation based training can be considerably cheaper.

The autonomous behaviour uses a simple route planner, and some flocking rules to determine group action. When instructed by a trainee, the instructions override the route planner, on the first instructions, but emotion registers increase frustration if different instructions are received and the avatars continue to follow their autonomous routes. When individually confronted by a trainee a human training controller takes over the avatar and uses natural language to interact with the trainee in a Wizard of Oz fashion since NLP is not up to the required standard.

The purpose of the testbed is to determine the required planning systems for the autonomous avatars, the best interface for the trainer to identify the past experience and personal state of the avatar when they take over control, the interface to control the avatar as such when interacting with a trainee, and then to set the autonomous avatar back onto autonomous mode again.

In the Brightown environment, the behaviour of autonomous avatars in response to the building on fire, and their interaction with user avatars.

3.1 TestBed Technology

The chosen technology is the Sony Community Place tool for VRML 2.0/VRML'97, including the multi-user virtual world server to provide consistency between user (Sony, 1988). Java is used to implement the AI and other active components behind the VRML 2.0 presentation technology.

In favour of this approach are

1) It provides a development environment and delivery platform to a wide variety of hardware and software systems;

2) It provides browser, authoring tool, and MUVW server tools, although these are not as powerful as the specialist tools used in the ARPA High Level Architecture (HLA); they are publicly available.

3) The virtual world itself can be developed in Division's DVI on a Reality Engine and translated to VRML 2.0 to add the AI.

while against it are

1) the low level of graphics primitives, but these are being overcome with the development of such example applications,

2) the low number of polygons which provides low visual quality, although we need to assess if this is sufficient to maintain presence in the task, this does put less pressure on the AI components.

3) the transmission of the Java code to the client takes considerable, although the AI code is portable too.

Using this technology allows us, as members of the VRML Consortium, to advance the "Living Worlds" proposal for VRML V3.0 (VRML Consortium, 1997) as and advance on the current V2.0 or Moving Worlds proposal (see Duce et al, 1997).

4 Conclusion

The notions of presence and engagement are what elevates a Virtual World interface beyond any other class. Presence is a measure of the user's immersion in the environment, that is derived mainly from sensory feedback, which in practice may depend strongly on visual qualities of the environment, and depends on the user building and maintaining a self consistent mental model of the environment. Engagement is a measure of the user's immersion in a task, or an emotional state, that is derived mainly from behavioural feedback, which in turn depends mainly on the available functionality and response.

In an IVE it is necessary to embody the intelligence in artifacts which can support presence and engagement. Given the limitation of AI technology and real time constraints provided by the need for presence, human controllers can be used to take over automated avatars when the application justifies the cost, and when the range of available functionality and response required to provide engagement is sufficiently high. These conditions are met in various training simulations for military, security and safety applications.

For these applications four main research questions exist about the design of the interface for the control operator 1) to be called, 2) to be passed control, 3) perform their control functions, and 4) hand back control.

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