Multidimensional Presentation Environments with Integrated Intelligent Agents

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Abstract

A Multidimensional Presentation Environment (MPE) is defined here as a digital environment containing spatially located data that can be navigated by a presenter. Given an array of data types and the potential infinity of the associated datascapes, there is an opportunity to develop systems that assist the presenter in the navigation and analysis of complex information scenarios. This research reports on the utilisation of intelligent agent based software for a better understanding of spatial information representation within the MPE. This is achieved by utilising intelligent agent software to aid the presenter in the searching, retrieving, and articulation of datasets, and the application of such technologies in the generation of time based 3D graphical and audio presentations.

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1 Introduction

This paper reports on research in progress into the development of a digital prototype 'presentation landscape' that explores the integration of intelligent agents in relation to visual and sonic arrangements of information. This research develops from a successful Australian Research Grant (ARC) application entitled: *Sharing Complex Systems Information by Challenging the Orthodoxies of Linear Presentation.* The project team spans two disciplines: spatial information architecture and computer science, connecting the information of space with the space of information. The objectives of the larger research effort are the human and social issues effecting decision making processes informed by spatial visualization and sonification with integrated computational support, especially in complex systems environments such as design collaboration, weather prediction, and disaster management situations. This paper reports on the developments to date of establishing the presentation prototype and the integration of Intelligent Agent support, and not the 'effectiveness' testing of such solutions.

1.1 Background

Comparative research of presentation orthodoxies has shown that digital media can assist where previous technologies were formally limited. Research at University of Maryland for example, at the Human-Computer Interaction Lab, has produced a software product (Counterpoint, http://www.cs.umd.edu/hcil/counterpoint/) that integrates zoomable user interfaces (ZUIs) to navigate 2D information. As an adjunct to MS PowerPoint™ this software reveals the advantages of simple panning and zooming through a ZUI to allow nonlinear navigation of information. This is described as a 2.5 dimensional presentation system (Good and Bederson 2002). Since the early 90s, researchers at Xerox PARC - User Interface Research Group have examined 3D approaches to digital arrangements of information http://www2.parc.com/istl/projects/uir/publications/project/index.html#uiiv). These explorations are related to single user navigation through components of information rather than presenter and audience presentation environments. Much of the pedagogy of architecture is based on the information of space and, in turn, spatial information. In the last decade architects have begun to explore the bridge between digital information spaces and constructed physical space, especially in museology. The Virtual New York Stock Exchange project by Asymptote (Couture and Rashid 2002) is one example that provides a digital simulation of a physical stock exchange with an overlay of continually updating information represented digitally. If this example succeeds on one level, utilising new media to deliver content to the requirements of the NYSE, it nevertheless offers little in the realm of digital spatial reconfiguration. Rather, it reinforces spatial concepts that mimic the physical world through a static model. The freedom of presentation media such as Counterpoint questions the need for strictly determined spatial constructs when dealing with information representation. Our research examines the role of dynamic systems for information presentation – with a specific case study of generic design based presentation information: images, movies, and sound. MPE and their navigation are inherently nonlinear with regard to user interaction and, as such, raise issues of the kind of decisions the user makes when traversing or altering these information spaces in a less determined manner than simply moving forwards or backwards. Intelligent agents are a leading edge technology that assist in the development and evolution of a range of complex systems – particularly systems that need to operate in real time in a dynamic and complex environment. Intelligent software agents incorporate the ability to reason about ways to achieve a desired goal in any current environment, and are able to adjust their behaviour to changing environmental conditions. The presentation of complex information in a flexible manner which can adjust to the specifics of an individual situation is a complex task with many specialised situations, different mechanisms available for different types of users, and different adjustments necessary to deal with environmental issues such as lack of sufficient information, inconsistency in information, unexpected information, etc. In this paper we explore in more detail how intelligent agent systems can assist in the kind of presentation tasks described, and we present the current MPE prototype and its three main components (visual, audio, data) before discussing the integration of intelligent agent support with this system.

2 Intelligent Agents

Intelligent agents are a new software paradigm, for which the terms of the initial research ideas (e.g. Georgeff and Lansky 1986, Bratman 1987) date back to the mid 1980s. During the 1990s the technology has been successfully used in a number of challenging applications such as air traffic control and space shuttle monitoring. In a number of papers at the Agents in Design 2002 conference (Gero and Brazier 2002), Gero et al. explored cognitive aspects of software agents in complex design processes. We are particularly interested in goal directed agents using pre-specified plans, such as those supported by the agent development frameworks JACK (AOS 2000), dMARS

(Kinny 1993), PRS (Ingrand, Georgeff and Rao 1992), JAM (Huber 1999), etc. These are referred to as “BDI” (Belief, Desire, Intention) agents, because of the way that they represent and work in terms of these kind of concepts. (In particular we use JACK, an industrial strength system for developing BDI agents, developed by Agent-Oriented Software in Melbourne, Australia). The plans in these systems describe a particular way of achieving a goal (or sub-goal) in a particular situation, known as a “context”. The goal directed nature of the agent execution mechanism provided by the system ensures that if an agent fails to achieve its goal using a particular plan, it will search its plan library and try an alternative plan if one is available. Appropriate plans for use are decided only when the agent is ready to achieve the sub-goal. Thus the choice is always made with the current situation in mind. Plans can also contain sub-goals, which allows for a hierarchical approach where goals are broken down into sub- goals, which may themselves be further broken down. At each level the appropriate plan for the current situation is chosen from the library of available plans. The combination of reactivity and goal-directedness of BDI agent systems make them an excellent candidate for complex applications operating in dynamic environments. In addition to this run-time flexibility, BDI systems are highly scalable. As new situations are identified and ways of behaving in those situations developed, additional plans can be added to the agent’s repertoire, with a description of the applicable situation. The area of complex information presentation is one where it is highly likely that new situations and new ways of presenting information in those situations will be discovered as the application develops. Thus this modularity and scalability is an extremely important characteristic for the application area. There are many aspects of preparing and delivering a presentation that could potentially be supported by an intelligent agent system. If we conceptualise a presentation as achieving a goal, we can see different kinds of presentations as achieving somewhat different kinds of goals, with varying sub-goals. For example we may have a goal to deliver a short introductory presentation in an area, which may have some alternative plans made up of sequences of sub-goals such as below:

Plan 1:	Plan 2:
Introduce area	Provide example
Provide example	Provide another example
Investigate one aspect	Summarise research question
Summarise research questions	Sketch possible solution
	Overview review

The intelligent agent system could then explore the space of possible sequences of images (assuming appropriately annotated sequences arranged by concept) and produce a suitable presentation, taking into account elements of the environment such as the interests of the audience, or the time available. Alternatively the agent system could interact with the user, suggesting options at different steps along the way. Agent systems provide an excellent framework for developing this kind of support – and doing so in a modular and scaleable way. However additional information must be represented and maintained in order for the agent to do its reasoning. The exact nature of that information is of course determined by what support one decides to prioritise.

3 Presentation Prototype

The prototype to date combines representations of datasets within a realtime 3D digital space. In this environment the presenter can navigate through a dataset arranged in a variety of spatial configurations with an accompanying soundscape. The software based interpretation requires the following capabilities: to interpret input from presenter, retrieve information, reconfigure visual and sound-scapes relative to information, and track the systems events.

3.1 Visualization and Audio Techniques

The MPE prototype is developed with a propriety software product Macromedia DirectorTM. This software has constituent

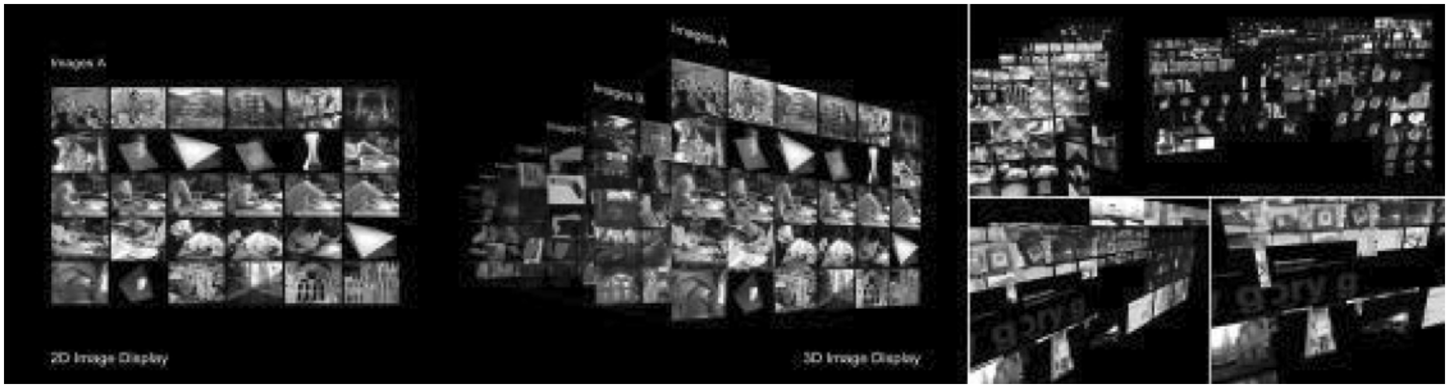

Figure 1. 2D thumbnail and 3D spatial arrangements within MPE

tools for dealing with digital media (text, image, digital video) and user interaction. Since July 2001 Macromedia (http://www.macromedia.com/) DirectorTM has included 3D components that incorporate OpenGL and DirectX graphics support. These components are controlled by the Director native language LINGO, and provide a similar environment to VRML (mesh geometries, bitmap texturing, lighting capabilities), but in a stable browser independent platform.

The MPE explores the nonlinear potential of image layout and navigation via the realtime graphics capabilities of Macromedia DirectorTM. Figure 1. displays two developed methods of image cataloguing. The 2D ‘thumbnail’ array allows lecture content to be accessed in nonlinear fashion, jumping from image to image, or sequentially. The alternative 3D arrangements allow for rapid recognition of content by an informed presenter, and context by the audience. The images are retrieved from a database and the representations are generated on startup of the MPE application, allowing easy exchange of content information. The configuration of the images is also flexible allowing for images and associated elements, titles, movies, links, to be arranged in a series of formations, be they orthogonal screens, or any transformation of coordinates, rotation, and scale. These arrangements are transmutable, so the space can be animatedly reconfigured between differing compositions of information elements. The audio component of the prototype integrates the concepts of spatialising sound relative to various datasets. Audio within the environment is critical to increased user understanding of their informational field. This research is interested in the development of acoustical environments that aid the user in two main areas; for thematic and navigation concerns. The sound components of this research develop from several key themes presented in the International Community for Auditory Display “Sonification Report: Status of the Field and Research Agenda ” (Kramer et al. 2001). With additional reference to extant research on the role of non speech audio for the representation of data dimensions (Walker 2000).

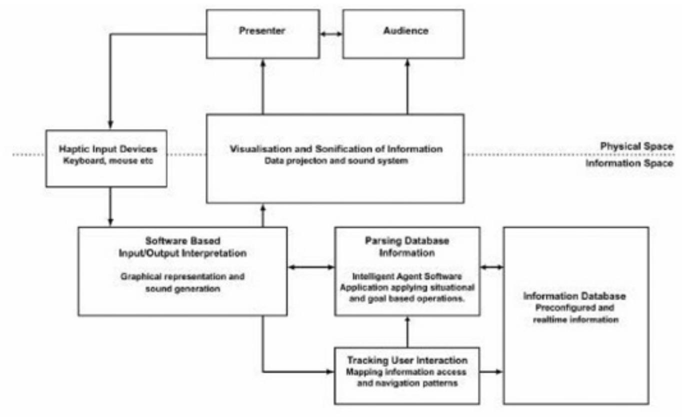

Figure 2. Schematic diagram of the MPE

3.2 Data Capturing and Intelligent Agent Connections

The current MPE prototype utilizes a series of external preferences and tracking systems to obtain user intentions and interactions. These form the primary source information in the dialogue between Director and JACK. At start up, preferences are (pre)defined for the initial criteria of the lecture (e.g. length of presentation, number of possible images, etc). Subsequent interaction data can be stored in an external database and exchanged with JACK via XML.

4 Integrating Intelligent Agent Support into the MPE

The fundamental elements to utilise and manipulate are: the data items for presentation, including descriptive metadata; historic records of past use, including presentation sequences and intents; and the current (or future) presentation plan – also sequence(s) and intents. This plan is a model of the presenter’s intent, but we may additionally need to model audience/user intents (or capture/infer them on the fly). The key question will be how accumulated history (experience) influences agent behavior. Items will need unique identification, since (planned) sequences can be reordered. On the other hand, how can one revisit a point in a stream of dynamic data? Must such data be explicitly recorded into the history, for later reference/use? The history should record for each item in the actual sequence presented, its duration (time on view), as well as “why” i.e. the specific concepts intended by the presenter. The latter could possibly be inferred from conceptual overlaps with adjacent items, unless the presenter intended contrast. A presentation plan will nearly always involve time bounds. It may simply be a list of high-level concepts and durations, or may involve more explicit sequences or subsets of individual items and durations. Plans may also include weights indicating the relative importance of particular items or concepts. Where a presentation plan includes time bounded concept sequences and the item database contains appropriate metadata, the agent can determine whether the items actually used conform to the plan. When too much time is spent on one concept, subsequent sections may be adjusted by proposing the removal of briefer or less important items. Conversely, when running ahead of time, additional items or even entire related concepts may be proposed. In the absence of relevant history, such suggestions must be constructed afresh from the conceptual graph of items.

5 Conclusion

The MPE prototype is an exploration into understanding the consequences of multidimensional information delivery aided by intelligent agent support. The questions that remain to be answered within this research include the degree to which presenters of the future are willing to be aided or guided by such intelligent agent support to design their information pool. The outcome of this research is to develop what plans the agents may undertake to assist a presenter within a spatial information environment, in turn generating a better understanding of decision making processes for presenters within complex informational scenarios.

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