Navigation Functionality for Virtual Archaeology

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ABSTRACT

The paper reports the ongoing functional specification of a virtual archaeology system. Taking into account the goals of ISO standards MPEG-7 and SEDRIS, we have summarized methodologies from related IT fields (visualization, multimedia, HCI and VR) relevant for virtual archaeology system functionality. One part of the ideas has been used to specify the functionality of a particular system for immersively exploring the ancient Greek excavations model within the Studierstube virtual reality installation. In particular, the visualization scenarios, navigation modes and sound spaces complete functionalities were specified. The results contribute both to current methodology and future research findings.

Keywords

Virtual archaeology, HCI, navigation, exploration, cooperation, methodology, functional specification

1. INTRODUCTION

Probably the first virtual archaeology reference is [Reil89], INSITE [Chal94] appears to be the first photo-realistic visualisation system - and it is not clear to us who coined the **virtual archaeology (VA)** notion. Regardless, virtual archaeology successfully bridges previously unrelated research fields: archaeology, art history, photogrammetry, computer graphics, scientific visualization, multimedia, human-computer interaction, and (collaborative distributed) virtual reality. Unlike most other disciplines there are combined both evidence and hypothesis. Our goal is to re-read the methodology in most of above mentioned fields, thus providing the methodological navigation guidelines for informed VA functional specification. The motivation for this research has been given by the development of our system within the EU project 3D MURALE [Cosm01].

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Navigation is the ancient Greek notion (cybernaut = navigator) and the title of this paper can be understood in a twofold manner – 1. (knowledge) navigation in the VA related methodologies, and 2. (user) navigation in VA cyberworlds as pars pro toto for the VA system functionality.

The following section re-reads the relevant methods. In section 3, we demonstrate the use of methodologic ideas for VA system functional specification. Section 4 offers the conclusions.

2. METHODOLOGY RE-READ

There are four fundamental program types that are being developed in VA today [ViAr99]: 1. database management, 2. statistical analysis of the data that is stored within the database, 3. image processing, and 4. modeling programs. The last ones use the data collected and the images created to model artifact assemblages in a relational manner and to create dynamic virtual environments where one can study the way in which different components of the past may have functioned.

The future goal of networked multimedia databases is **interoperability** [MPEG-7] and **unambiguous representation of environmental data** [SEDRIS02]. There is the need to represent both interior and outdoor scenes, "all environmental domains".

The virtual archaeology processing pipeline [Chal94] is to a certain extent implemented in each VA system. The workflow combines digital elevation model with photogrammetry, antiquarian and excavation findings into the phasing and structural scenarios. This is the **evidence** part, where both archaeological research and computer model apply. At this point the hypothesis layer of processing starts. From structural scenarios there are derived the ritual and lighting scenarios. The interactive system enables for creating alternative **hypotheses**, which can be included into the database of ritual scenarios.

Scientific visualization uses visual methods to facilitate analysis, understanding, and communication of models, concepts, and data in science and engineering [Hear91]. Data come from simulation or observation and they are filtered, mapped, transformed, and displayed to enable the analysis. Visualization scenarios are **movie-mode, tracking, interactive post-processing, and interactive steering**. Display of numerical data in visual form, or representation, is a multifaceted issue (shape, color, expressiveness, interactivity, dynamics…). Special part of visualization is the **time visualization.** According to German philosopher I. Kant, certain aspects of reality are not directly perceivable, they are a priori. An example is the time. Kant means that time is the "intuition" added by our brain while sensing other sensible data. It has no bit string representation. It is accustomed to display it as the coordinate axis with the tick markers. Audio analogy provides the sound of ticks.

Multimedia well-known ISO definition sounds: the creation, editing, composing, and/or presentation of products consisting of any combination of media [PREM96]. The general "multimedia coordinates" are proposed in [Adzh98]. They include world coordinates, dynamic (time dependent) coordinates, spreadsheet coordinates, photometric coordinates, transformation coordinates, and audio/video coordinates. Finally, these two worlds – multidimensional objects and multimedia objects - can be integrated using F-rep approach [Pask95].

Sound. Sound offers more information [Ming95]: scene and "view" extension, emotional content, real sounds from model and reality. It is an inevitable medium for visually impaired. According to general semiotics, sound can be used as iconic, indexed, symbolic representation of meaning, plus context-dependent signal. The particular ways differ for speech, music and non-speech audio cues. VRML supports the 3D sound and the spatialized sound is well-studied.

Unlike audio and video, haptic devices [Hapt01] are quite rare and therefore we see no relevance of **haptics** for VA now, except the possible Braille interface.

Human-computer interaction (HCI) is a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them. Well-designed HCI solutions have to address very simple one, very beginning user and very advanced user, an expert in the field.

HCI researchers use an unique methodologic approach – the **metaphor**. E.g. standard GUI is based on a desktop metaphor. A very interesting Magic Mirror metaphor for assisting the exploration of Virtual Worlds has been proposed in [Gros99].

Virtual reality. "Systems that create a real time visual/audio/haptic experience", [Vinc98]. It is worth to distinguish among five virtual realities. They are basic VR, augmented VR, projected VR, immersive VR, and Multi-user Distributed VR. Moreover, there exist overlaps in research directions like Mixed Reality. The VR languages include well-known SuperVR, QuickTimeVR, VRML and MPEG-4.

We assume one user immersed more or less in the basic VR, immersive VR or projected VR like CAVE. The user has to deal with **interaction** and **navigation**, as distinguished by [Vinc98]. The movement inside the workspace can be done in at least four different manners: general movement (walk), targeted movement (fly), specified coordinate movement (absolute or relative), and specified trajectory movement.

Obviously, visualization, multimedia, HCI and VR fields significantly overlap. In the next section, we report the inspirations for VA.

3 Virtual Archaeology System Functions

In the following, we propose one part of VA functionality. The functional specification can be divided into application content independent and dependent parts. E. g. ancient music or languages can be used meaningfully in the appropriate context.

3.1 Extending General VA System Functionality

Visualization scenarios can be easily implemented by any VA system. Movie-mode represents the off-line taped video, analyzed by the user at the VCR. Tracking involves interaction without data change, and interactive post-processing enables for editing the model data. Interactive steering resembles the immersed user and her/his exploration of the virtual world. The simpler scenarios enable both for exploration storage and post-immersion analyzing.

Terrain simplification and building demolition. We have increased the realism of the surrounding countryside by a group of virtual buildings. The same can be done using artificial vegetation, population, using billboards. During the terrain simplification the virtual building demolition supports the realism.

The Informed Sky. The time visualization can be proposed for VA applications by a special way, limited to the written history part. The life times are displayable by a cloud of horizontal line segments – in the sky area. The ordering of them can be according to date of birth, as used in [Gomb89].
NPR viewers. The inspiration both from art and visualisation led to the intensive research in non-photorealistic rendering [Gooc01]. "Defined by what it is not, non-photorealistic rendering brings art and science together, concentrating less on the process and more on the communication content of an image."

Head Light. The explorations of excavated ruins in the sunset or night time has another athmosphere and our system will provide this by employing the simulated sky intensity decrease and headlight. Headlight we model as a spotlight in the camera direction (attributed visualization).

Sound Spaces. Creating the sound spaces for VA system we divide into three parts – model, navigation, and interaction. The family of possibilities consists of music, voice (in several languages), and audio non-speech cues. Each of them may be used in iconic, indexed, or symbolic representation. The sound can be used as a (time) signal. The sound space events can be organized into the sound-trees. One part of interaction can be alternated by microphon sensed commands.

The silent virtual world appears unnatural. The simplest audio is a pleasant music. The intensity can vary from zero to maximum thus giving the indication of the distance. The alternative to music is the sound of blowing wind. Although we have mentioned that haptics has no VA relevance now we consider to improve the perceiving in combination of sound and wind. Incorporating the real air blow using wind generator into the Studierstube installation is quite cheap and technically possible. The interaction and navigation events can be sound-driven, especially for a blind user.

3.2 3D MURALE Specific Functions

The inspiration for specific functions cannot be derived in general. There is a phenomenon named genius loci, the spirit of the place… A subset from the above given functions has been or will be applied to data available from the 3D MURALE project [Cosm01]. This virtual archaeology project aims to provide a complete workflow from helping the archaeologist in the field to visualizing the scientific conclusions. We focus on navigation facilities for fourdimensional exploration of fuzzy data [Grab02b] (i.e., in fact, five dimensions). We use the personal interaction panel [Szal97b] (pen and notebook metaphor provided by the Studierstube [Szal97a] API) as input device.

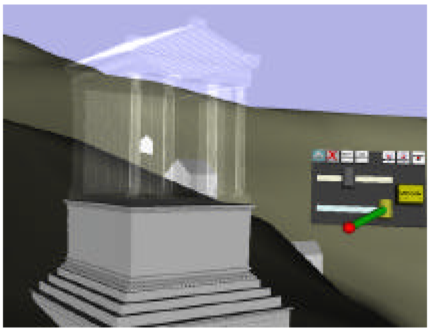

Figure 1: Increasing the desired level of confidence (i.e., moving the PIP slider to the right) causes objects partially disappearing.

Due to the long period of interest an archaeological site is considered a dynamic entity. Based on archaeological evidence (e.g., architectural style of the period), it is often possible to reconstruct the site at different epochs. While some of these reconstructions are based on scientific facts, there might also be cases where the reconstruction is only a vague assumption. And, of course, artists should be allowed to add objects to the scene just to make it more appealing and more complete.
Our system provides sliders integrated into the VR world (i.e., projected onto the PIP) that can be used to select the time in history and the desired level of certainty. These sliders act as filters to select a subset of the scene for rendering corresponding to the user's choice, see Figure 1).
For 3D navigation, we employ general movement (walking on the surface) interactively steered by a 3D pointing device. A variation of the motion constraints (fixing the user's position above ground instead of his elevation) offers an intuitive way to explore the third spatial dimension. Targeted movement (flying) is achieved by removing motion constraints.
Two obvious solutions for specified coordinate movement are the virtual laser pointer (move towards the object hit by the ray) or the virtual clickable tourist map overlaid on the PIP. Both methods can also be used to specify a trajectory, making the four

navigational motion types complete.

4. Conclusions

One part of the functionality coming from the summarized methodologies from related IT fields appears relevant for the virtual archaeology. The specified functions were implemented or are a part of the future work in a system for immersive exploring the ancient Greek excavations model within the Studierstube installation. The navigation modes and sound spaces can be used for the support of different user strategies. The future work will include more experimental evaluations using standard sociologic methods for measuring the quality of immersion, educational value, and ease of communication.

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