A VIRTUAL COLLABORATIVE ENVIRONMENT FOR ARCHAEOLOGY THROUGH MULTI-USER DOMAIN IN THE WEB

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ABSTRACT

The VHLab of CNR-ITABC is developing new research projects oriented to virtual archaeology and to the study and communication of cultural heritage through multi-user virtual reality applications (off and on line). The state of art in this field is still quite pioneering, because there are no multi-user domains (MuD) for sharing and exchanging cultural and scientific contents, in the field of virtual heritage. In effect, the use of virtual reality systems in the interpretation process in archaeology is not frequent and probably these potentialities have to be explored in detail.
A FIRB project, "Integrated Technologies of robotics and virtual environment in archaeology", financed by the Italian Ministry of the University and Scientific Research, gives us the opportunity to experiment and realize a multi-user domain on the web aimed to a multidisciplinary scientific community: archaeologists, topographers, historians, experts in human and social sciences, communication experts. The capacity to load, share and interact with data in the same spatial virtual environment can increase the level of learning and scientific communication; in this way the information become hyper-real and contextualized.
The project is still a work in progress, we expect to complete it in Autumn 2008. In the following paper we'll present the general scenario of the applications, its aims and methodologies, together with the first results.

1. AIMS AND TARGET OF THE PROJECT

1.1 Introduction. Virtual Reality as a new opportunity for scientific community

In the last ten years the integration between visual technologies and cultural heritage has been developed through theoretical discussions, publications, applications, but, especially in the virtual reality domain, results are still quite partial in comparison with the great potentiality of virtual reality in this field of applications. It is not only a problem of accessibility and sustainability of digital technologies: the real problem is the creation and dissemination, in the field of cultural heritage, of a new language, a new alphabet, new metaphors of interaction, that can be recognized and accepted, first of all from the community of experts, as a new, useful approach both in interpretation processes and in communication of cultural contents (Antinucci, 2007).
How technologies, and in particular virtual reality, can develop the organization, visualization, interpretation of cultural contents? How can they support us in the creation of integrated informative systems? Which are the most efficacious ways to interact with models and metadata? How can we share and exchange data? How can we make a model or a reconstruction "transparent"? (Forte, Pescarin, Pietroni, Rufa, 2006).
In very few cases virtual reality applications in the field of cultural heritage are oriented to scientific communication. There is a relevant difference between humanities and other scientific fields, like medicine, mechanics, physics or industrial design, where, on the contrary, virtual reality is a fundamental approach for simulation, research, interpretation and learning.
We think it could be very important to use the "virtual" also within scientific communities of expert in cultural heritage. In fact, archaeological research produces during the phases of acquisition, post-processing and communication, huge quantities of spatial data, disseminated in different archives (with various formats, ontologies and typologies).
The consequence is that the process of interpretation and communication becomes partially compromised, or even obstructed, by the inaccessibility of all data inside the same informative system.
On the basis of these considerations, and since actual methodological and multidisciplinary approach to these problems still appears full of gaps, it is very important the creation of a new virtual reality system able to interact and connect with complex and multidimensional-multiscale data, according to three different macro contexts: intrasite, site/ monumental site, landscape. This paper and scientific work is part of the FIRB (Funds for the Investments of Basis Research) proposal "Integrated Technologies of robotics and virtual environment in archaeology", supported by the Italian Ministry of Scientific Research (MIUR).

The project, in collaboration with the Department of Archaeology of the University of Pisa and with Scuola S. Anna of Pisa, focuses on three archaeological sites: *the Teban tomb 14 in the necropolis of Gurna-Luxor, Fayum Medinet Madi*,

both in Egypt, and *Khor Rori,* in Oman. In these sites many reliefs have been realized and others are going to be done in the next months, using different integrated techniques of data acquisition, elaboration and representation (scanner laser, photogrammetry, 3D panorama, computer vision, GPS topographic relief, 3D computer graphics). Because of the complexity of spatial data, new metaphors and interfaces of interaction are planned in order to stimulate narrative and anthropological interpretation of cultural and symbolic content of places through the time (figure 1).

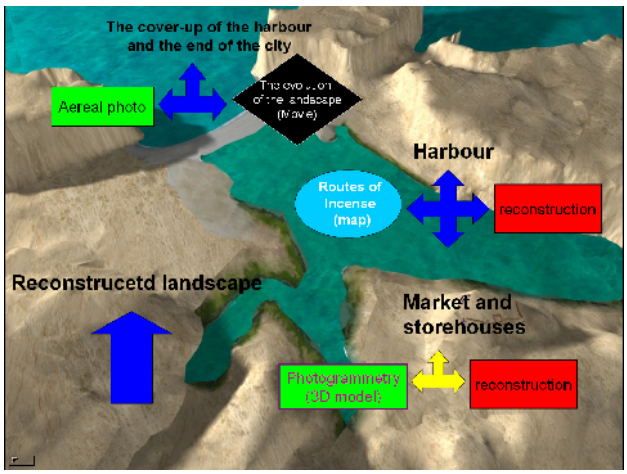

Figure 1: a schematic representation of some key-concepts referred to the site of Khor Rori (Oman) and, for each one, linked metadata and levels of contents and representation.

All these data converge in a virtual scenario where a web community can interact in real time. In this virtual space we assume to draw the complex pipeline connecting scientific knowledge and communication and validating the entire process of interpretation. The final aim is to create a virtual museum, a digital environment where scientific community can meet, interact, exchange and test hypothesis, share data and ideas. This virtual space will be an editable and dynamic environment in continuous evolution; throughout the multiuser domain the users can meet, dialogue, and interpret archaeological virtual reconstructions or cultural contents, according to their own interpretation and hypotheses. Every new version of the virtual environment is uploaded on the web as "portal" of the MuD, so that many diverse informative worlds can coexist and be compared in real time.

1.2 Data transparency

The issue of the transparency and of validation of scientific data is the core of a debate at international level in the field of virtual heritage. How much is reliable a virtual reconstruction? What kind of relationships-affordances we can identify in it? Until today most part of the virtual reality applications and computer reconstructions concern "closed" and not transparent models: therefore it is impossible to validate the entire pipeline used during the interpretation process. It means that the user is not able to understand how the reconstructions were made and can't validate them (Forte, Pescarin, Pietroni, 2006). The methodology of archaeological research involves two opposite approaches: *bottom-up* and *top-down*. The first one reconstructs models and shapes from traces visible on the ground and from the fieldwork (spatial data acquired with different techniques). On the basis of these data and according to the method of processing and selection, a 3D model is elaborated. The *top-down* approach infers information and models on the basis of comparative mental patterns, strengthened cultural examples, interpretative analyses, and so on.
The integration of bottom-up and top-down approaches in the same virtual environment is a fundamental step for validating the interpretation process and increasing the level of knowledge. At this point, the transparency of the process depends on the capacity to share information, simulation, (possible) reconstructions, metadata. In these terms it is possible to promote a continuous debate between the scientific communities but even in the educational field..

2. DESCRIPTION OF THE PROJECT

2.1. Multiuser Domain

The collaborative environment (MuD: **Multi-User Domain**) is constructed through a virtual reality system. This allows to create a virtual space where it is possible to share 3D information on the project and to host additional behaviors of the scientific community. This "gate" has to be a common interface for the 3 archaeological case studies: Gurna, Medinet Madi, Khor Rori, (figure 2).
A first experiment will be realized off line (2006-2007), then an on line prototype will be created in 2008.

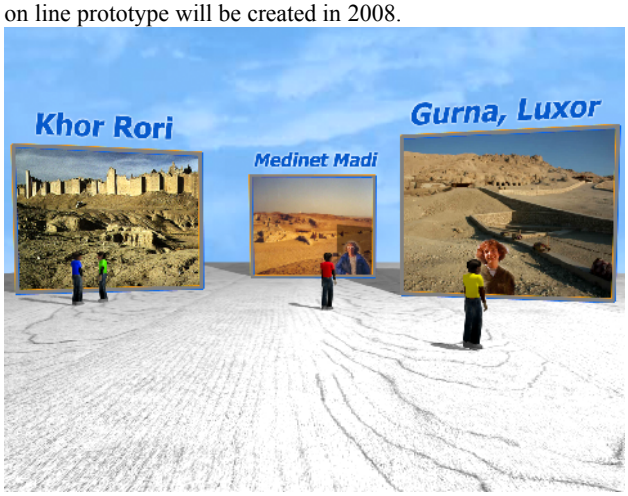

Figure2: main interface of the virtual world, with "portals"to the three archaeological sites interested by the FIRB project.

The main features of the software are:
1) to represent a powerful tool able to increase the information exchanges and the progress of the research within the scientific community;
2) to develop a digital workflow oriented to the transparency of the interpretation process;
3) to create two main environments: a scene editor (off line) and a visualization engine (on line) to share between multiple users.
4) to develop multiusers domains where each user is represented by own avatar and can interact with the others (web-community).
5) to be a communicative, open and social tool for scientific communities and registered users.

2.2 The scenario in 3D: descriptive models or "cybermap"

The 3D space is the main interaction interface to integrate and connect information, in order to create a network of relations among data. For this reason the virtual scenario can be both realistic and descriptive, elaborated from topographical data acquired on the field, or totally abstract, symbolic, a network of spatial and interconnected informations. In this case it can be

composed by simple geometries, with elementary iconography, distributed in the virtual space according to an established map. The cybermap is a symbolic environment, a cognitive space, where contents are represented through an abstract code; simple geometries will suggest objects, media or metadata, different shape and colors can be associated to particular properties of objects according to their similarities, affinities or correspondences, (Forte, Pietroni, Rufa, 2002), (figure 3).

Figure 3: the virtual Scrovegni Chapel (*CNR-ITABC*) with the iconographic space and the symbolic cybermap representing the informative network connected to the painted scenes and implemeted in the application.

The map/network will be constructed around a "key concept", main attractor of the cultural theme or of the interpretative proposal. The network can include, around this "key concept", links to metadata (texts, video, audios, sounds, images, multimedia), 3D models, or other virtual environments that can be associated to the main key concept, (figure 4).

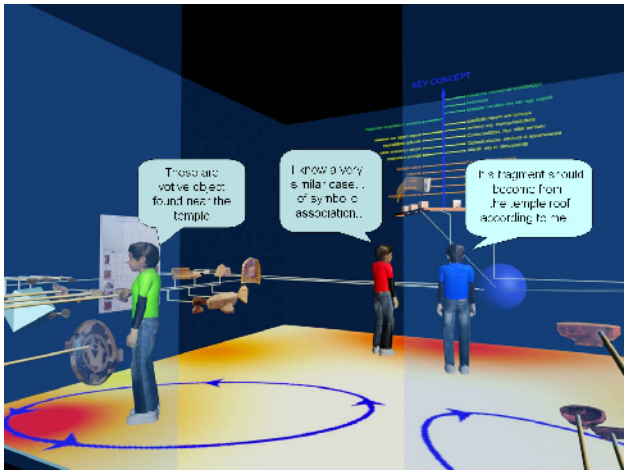

Figure 4: an example of cybermap referred to an archaeological context attendend by a virtual community (*CNR-ITABC*).

So we have a conceptual 3D "cybermap", whose aim is to propose, enhance, simulate the network of relations we establish among data. The way we connect these data is the result of our interpretative process, dynamic and multidimensional: according to the kind of relations we want to establish among objects of a context (chronology, typology, topography, simbology, hierarchy, material...) the map/network changes (Pietroni, Forte, 2006) .

CNR-ITABC will realize, for this project, both realistic three-dimensional scenarios, from data acquired on the field through topographical survey on the three sites (*Gurna-Luxor, Fayum Medinet Madi, Khor Rori)*, and symbolic cybermaps in order to test this new kind of metaphors of data relations.
Final aim of this project is not to create a definitive virtual museum on line, a closed model, but, on the contrary, to build different scenarios or "gates", created by a scientific community. It is not a final result but a tool of interpretation and discussion. The infrastructure is totally open, in the future the community could be expanded to many other projects, keeping, of course, the same general approach and interface (dynamic network, transparency, behaviors, editing tools and so on).

2.3 The application: *off line editor* of scene and behaviours and the web community *on line*

The software has to provide tools in order to create and visualize editable digital environments by every user of the web community. The software includes two main applications:
1) the scene and behaviours editor, *off line;*
2) a real time graphic engine MuD-oriented, *on line.*

We give a general overview of the system. The first "author" creates a 3D space in the scene editor. He/she can also import, 3D models from other softwares, using compatible formats. The scene is then saved in a text formatted file (XML for instance) that can be later opened and edited by other users within the same editor.
These are the main functions of the *off line editor*:

- loading of 3d models realized with other softwares (wrl, 3ds …)
- switch to other views;
- loading of different textures on models;
- tools of lightning;
- tools of measurements;
- tools of drawing (lines, shapes in the 3D space);
- highlighting of areas;
- move, hide or view, scale objects;
- change the map;
- de-construct and reconstruct the models;
- change/integration of models according to graphic libraries or inventories;
- links of metadata to 3D models;
- visualization in the 3Dspace (movies, audio comments, texts, images...).

Each user can choose an avatar and enter in the web community: so he/she can visit, interact, dialog, open cultural contents, metadata and so on. In case of changes of scenarios, it is possible to download and modify the virtual environment in the scene editor. For example it is possible to transform the conceptual map of the information system, or to modify the cybermap creating new key concepts and new relations, moving objects and linking metadata. At the end the users can save the contents in text format, and upload the scene on server with additional metadata or contents.
All the following versions elaborated by the users will be saved in a repository on the server and accessible by the web community through a special interface. The architecture of application is open: graphic tools and behaviours are implemented, inside both the editor and the MuD, as separate modules.

Avatars can meet in the virtual space and dialogue through chat, or webcam, projecting their video-presence on special virtual screens inside the digital scenario.
These are their main behaviours:

- walk through in the 3D space;
- measure and light tools;
- talk (chat, webcam);
- models editing (hide, reveal, move, scale objects);
- download contents;
- thematic visualization of models;
- accessibility to metadata and multimedia contents.

3. CONCLUSIONS

Virtual Reality is a well known technology in any field but for the humanities seems just a didactic tool not very appealing for advanced researches. Typically the scientific communities don't consider VR environment an operative tool for the archaeological research and, in particular on the web, there are a few examples of 3D e-learning and e-communication. Why? Apart from some technological restrictions, it is not yet common to share interpretations, hypotheses and data in the same virtual domain. On the contrary, a 3D space should be a simulation environment, a hyperspace where the interpretation is represented by a dynamic process, by cybernetic feedbacks, by mutual interactions (Forte, 2007, Annunziato, Pierucci, 2002*)*.
It is a big challenge for the future of ICT and for the field of virtual heritage to plan the possible guidelines of cultural communication, and it is quite urgent to discuss about methods, technologies and epistemologies. The separation-segmentation of information in separated domain (linear texts, models, spaces, maps, taxonomies, etc.) decreases the level of knowledge and not validates the interpretation process. So the risk is to construct cathedrals of information free from any reliability and communication processes.
The contextualization of spatial information in a shared environment, such as the case of archaeology, allows a different understanding of landscapes, architectures, objects, sites, and a cognitive comparison and testing of diverse viewpoints, analyses, and hypotheses.
In the FIRB proposal because of the cultural and typological difference of data and contexts (in 3 sites), the multiuser environment is the best methodological solution. Every site is a portal of archaeological communication and a simulation space for re-contextualizing archaeological information in a new unexplored virtual place.
A key problem on the use of VR collaborative environments in archaeology is that there are very few case studies and we need time for encouraging the scientific community to use this kind of communication tools. In addition, it will be interesting to study the social behaviours of scientists, teachers and students within the virtual space and interacting in 3D with spatial data, cybermaps and landscapes.
Actually we are planning to create a prototype of the system for 2008, so in this phase we are optimizing 3D models and information for the virtual environment. Basically we have to collect all the data from the fieldwork into the 3D space for the three archaeological sites, and then we will integrate the virtual environment with 3D graphic libraries.
In terms of use and interaction it is possible to plan two main goals: education and scientific communication.
A possible scenario is the virtual classroom where the teacher can interact in 3D with the students, discussing about key features of the archeological sites, interpretations and general overviews. Secondly, the students can directly build a scene of an archaeological context on the basis of the data available on line. So they can edit models and 3D spaces, link metadata and multimedia contents, discuss on research and methodologies. The final aim is to validate the interpretative and reconstructive process and to share all the activities with the rest of the community/classroom. The final result could be an open portal where the teacher can evaluate the result.
In terms of scientific communication the users will choose three portal and scenarios: Gurna-Luxor, Medinet Madi, Khor Rori. The rights of registered scientific users will permit to edit scenes, upload data and change models, the rest of the users could interact with the virtual worlds but without the possibility to modify the scenarios. In this way we assume that the multiuser environment is an informative world in progress, updatable according to the development of archaeological fieldwork and researches. In the same time it will be also a simulation space where it is possible to integrate bottom-up and top-down approaches.

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