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Pushing the Archaeological Interpretation by Analysing Workflow Protocols: The "Variable Transparency Image Stacker" and DATARCH© Archaeological Data Management System

Abstract: The main aim of this study is to investigate the possibility of managing archaeological data in a shared 3D environment. As already published by our research group, study and analysis of workflow protocols are the basis for the development of software able to support and improve archaeological data management, by introducing new methods and tools to analyze archaeological excavations (e.g. the DATARCH "Variable Transparency Image Stacker"). The progress of Web 2.0 and shared technologies makes it possible to go deeper with this research into archaeological workflow protocols and data management, exploring 3D distributed environments and the possibility of their application to archaeology in particular. The case studies selected for this research are the recent excavations carried out by Università degli Studi di Napoli Federico II in Foce Sele Hera Sanctuary and in the Cuma Forum.

Introduction

Cultural Data Management procedures based on ICT methodologies establish that the relation between data and its organization is crucial to the process of analyzing remnants from the past. Nowadays, data and its organization are assumed to be deeply intertwined. The supposed neutrality of data, which was assumed in the first phase of studies on archaeological data management, has been disproved in recent studies (Fabricatore / Cantone 2006a).

The analysis of the archaeological workflow has been the focus of the first phases of our study. This phase of our study was dedicated to the examination of the elements (i.e. phases, operations, tools, relations, people, skills, etc.) and the processes that constitute archaeological research on the field. It aimed to both describe these elements and processes and to develop software and tools to support and to improve them.

Starting from this methodological background, this study attempted to develop archaeological data management protocols based on efficient, modular, interoperable, user-friendly support tools. The archaeological excavations of the Foce Sele (Paestum) Hera Sanctuary, directed by Dipartimento di Discipline Storiche E. Lepore of Federico II Napoli University, were selected as a suitable case-study because of their particular problems of data acquisition, management, storage and analysis. These problems were due to the very convoluted history of the archaeological investigations of the area since the very first exploration in the Thirties, by Paola Zancani Montuoso and Umberto Zanotti Bianco. (Zancani Monturo / Zanotti Bianco 1951–1954).

A systematic compilation of the archaeological data from the Sanctuary, directed by Prof. Giovanna Greco, gave us the chance to apply new methodologies to the Foce Sele case study (Greco / Ferrara 2003). The first result of the study was the development of a new archaeological data management system/workflow protocol (DATARCH), whose main features are a strong integration between photographic and alphanumeric documentation, an easy-to-use interface and an efficient architecture that fits naturally with archaeological operations and tasks (Fabricatore / Cantone 2006a). Starting from this first phase the research went on to investigate the possibilities for better integration with Internet technology, and with Web 2.0 in particular.

Web 2.0 and Shared Technologies: Applications to Cultural Heritage

It is well known that in recent years the Web has been rapidly changing towards the so-called "Web 2.0".

Web 2.0 changes the vision of the Web completely: information is no longer stored in a net of web pages, but rather arranged in many cells of

content, shifting the architecture of the web from a network of documents towards a network of data. At the same time, Web 2.0 moves from an environment in which information is only read ("read web") to an environment in which content may be created, shared and reused ("read and written web").

Multimedia vocabularies, blogs and wikis are but a few examples of the new concept of the Web, where, with the support of these tools, even new virtual communities are being established (Levy 2003). In particular, file-sharing technologies, hub-based applications and Peer-to-Peer (P2P) technology have been recent topics of worldwide discussion and interest. Peer to peer technology has the capability to introduce a new paradigm of networking, and is today perceived as one of the "killer applications" of the Internet (AAVV 2001; Barkai 2004; Fattah 2004; Mitchell 2004; Oram 2004).

Whilst hub-based applications initially gained attention in connection with the success of legally questionable file-sharing clients such as Napster, Gnutella, FreeNet, Seti, WinMx and KaZaA, now interesting developments are related to the application of these technologies in the fields of business and education. The main business-related applications involve distributed content management in connection with Supply Chain Management (SCM), Customer Relationship Management (CRM) and e-commerce. For educational purposes, shared technologies offer remarkable possibilities in improving interaction, finding interesting applications to all projects that require information interchange and networking (Gartner 2001). In the cultural field, archaeological workflow management may be an interesting case study to test the advantages of shared technologies in archaeology (Cantone 2005). It is well known that data management is one of the first and central fields of application of ICT technology to archaeology (Lock 2003).

The main current trends in the archaeological data management field can be summarized as follows: (a) the development of systems able to support cross-interoperability with a wider range of applications, (b) research of standards to make interoperability possible and (c) research into better data integration. Since shared technologies seem to be able to support the requirements of archaeological data management, our research has focused on the exploration of their possibilities for the cultural field.

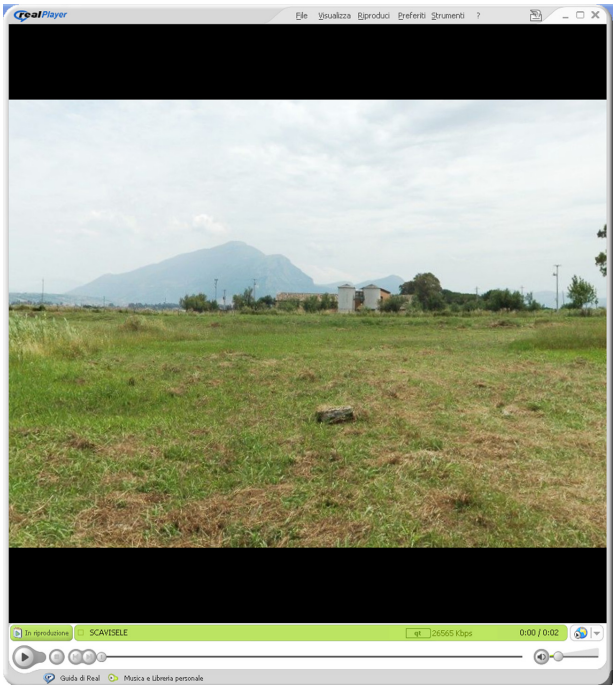

Fig. 1. Panoramic view of the excavations in Foce Sele Hera Sanctuary and of the Museo Narrante (Greco / Ferrara / Cantone 2007).

DATARCH: Project, Methodology and Development Strategies

As pointed out above, since its first steps this study has aimed to address the need for archaeological workflow protocols and for software tools to store, analyze and integrate excavation data and graphical information. The current application was developed by taking advantage of the features of the MS Visual Studio.Net environment. This Integrated Development Environment (IDE) allows the creation of multilingual programs and supports step-by-step development procedures, both in the present release and for future versions of the program.

The realized software, DATARCH (Data Acquiring and Sharing System for Archaeology and Cultural Heritage), can handle all the required formats of excavation operations data: alphanumeric, photo / graphic and other miscellaneous documents (Fabricatore / Cantone 2006a). In this phase of the project, we are moving from the concept of a standalone application that users can install on the target machine with the provided installer to the implementation of an interface to access a web-based system for "Archaeological Data authoring & sharing",

supported by an XML & Multimedia DBMS (Chianese et al. 2004; Chianese et al. 2006).

The current software has an efficient and easy to use structure: after an essential and functional Starting Panel, enabling basic operations such as logging in or logging out and viewing a short help file, the user can enter the Main Form. This interface provides access to the highest level operations, organized in a semantic and hierarchical structure. The interface design aims to assemble functions as much as possible, so that the user can complete a task with the minimum number of actions. Graphics, icons, colours and directions collaborate to convey meaningful signs in a semantic environment.

DATARCH's key-concept is to reproduce the archaeological research workflow, from data acquisition (ACQUIRE), to data management and analysis (ANALYSE), to data publication and reporting (SHARE). Data input (ACQUIRE) is distributed over several acquisition forms, which use tabs to aggregate information meaningfully for quick and easy recording. The analysis area (ANALYSE) gives users different tools to interrogate data: among them, the Dynamic Query Tool allows users to create queries by combining all the features and records of the data set; tables are listed in a menu, in which the user can select which data set to study. The aim of this strategy is to provide flexible solutions to managing and examining data. By doing so, DATARCH provides an analysis procedure more useful than a raw set of pre-defined, but numerically and methodologically limited, solutions.

New solutions have been investigated to manage photographic information in response to methodological issues raised during the 2004 excavations in Foce Sele Hera Sanctuary. During that period, tests and experiments were performed to study the possibility of better exploiting information collected using photographic techniques by increasing the quality and scientific value of the acquisition and management processes. First, guidelines were drawn to integrate orthophotographic and stereophotogrammetric information in Foce Sele Hera Sanctuary documentation. Orthophotos of archaeological strata were rendered and overlapped in semitransparent layers over excavation drawings. This allowed a quick, economical, in-situ quality check of graphic documentation drawn using traditional techniques.

This feature was integrated in DATARCH by developing a tool called "Variable Transparency Image Stacker". When DATARCH is installed, it creates an folder named "IMAGES" on the user's hard disk.

Fig. 2. DATARCH starting panel.

In the ACQUIRE panel, a wizard allows the user to drag and drop images into the IMAGES folder, to easily store them. The images are then ready to be processed by the "Variable Transparency Image Stacker". The Stacker makes it possible to select the various orthophotos of the different strata, stored in the IMAGES folder, and to overlap them. A panel allows images to be chosen and the transparency value of the different layers to be controlled. The "Variable Transparency Image Stacker" has been included into the DATARCH system to introduce the concept of "syncro-diachronic photography" and to exploit its application advantages in archaeological interpretation. The Stacker makes it possible to dynamically reconstruct a stereo-vision of the excavation in order to analyze spatial relationships among archaeological strata. Further studies will investigate the possibility of linking alphanumeric data to its photo / graphic representation.

It is useful to point out that the tools developed provide a method for examining excavations based on their photographic representations. The syncro-diachronic photography is integrated in the archaeological data management system and supports the whole process of construction of knowledge. Thus this phase has been the first step in the process of developing a virtual reconstruction of archaeological excavations based on overlapping 3D images of strata. The stereo-visualization of the excavation may lead to a complete and direct analysis of the archaeological information based on images and on their interconnection. This has the potential to reduce the present necessity of symbolic graphical reconstructions, or alternatively could help with the integration and automatic generation of such reconstructions.

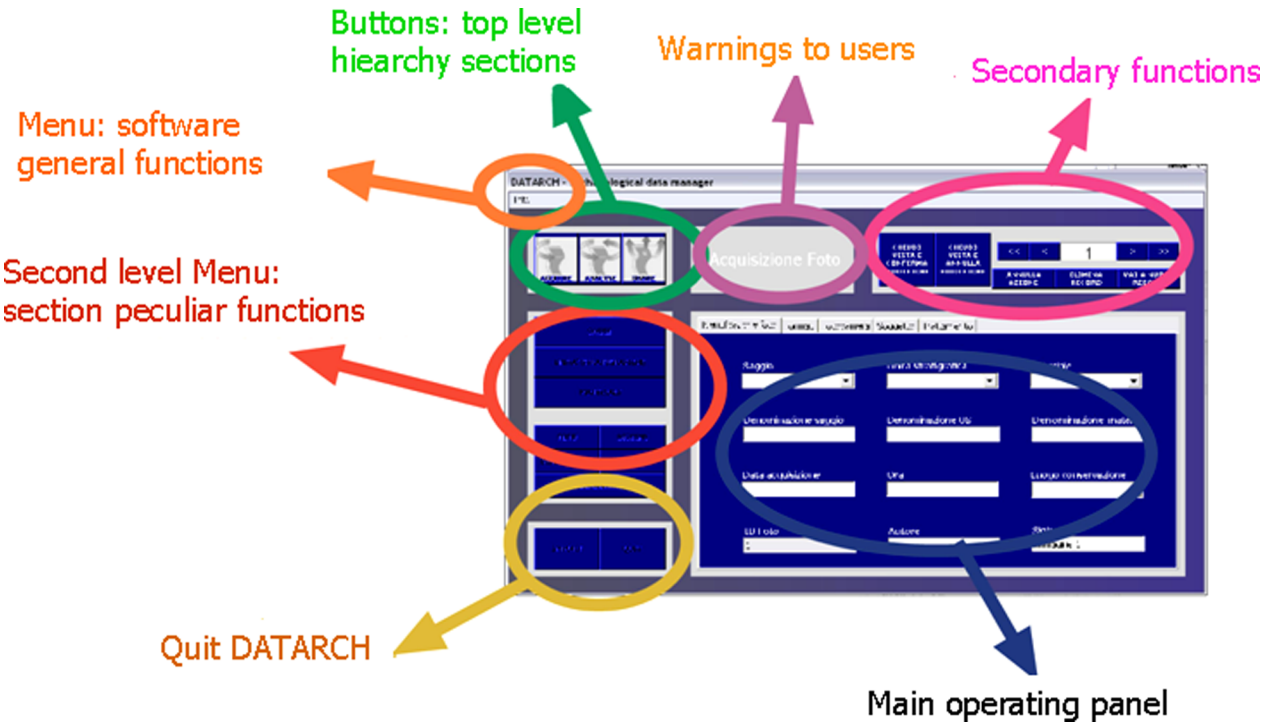

Fig. 3. DATARCH interface strategy.

Finally, DATARCH is completed with a reporting area (SHARE) which allows users to produce various kinds of reports, including standard Italian Ministry forms, and catalogues related to editions of Hera Sanctuary archaeological data. DATARCH can be further extended with extra customized reports.

Main Benefits, Further Developments and Perspectives

Beyond this phase of achievements, the research outlined in this paper can be considered as a methodological background for additional studies dedicated to the enhancement of archaeological data management systems. After a preliminary phase dedicated to analyzing the methodological context, the operative phase of this study led us to define, propose and test a new protocol to manage and check workflow quality in archaeology. These normalization needs have been mainly addressed with the development of a new archaeological management system prototype, called DATARCH.

At this stage of the project, DATARCH's main benefits are: (i) A data structure and an interface which fit the archaeological workflow (the ACQUIRE, ANALYSE and SHARE panels guide users to the relevant operations) and (ii) the integration of syncro-diachronic photography via the "Variable Transparency Image Stacker." This tool allows for the analysis of excavation data in a new, completely visual way. Analysis of archaeological stratigraphies is supported by an image stacker which allows orthophotos of different strata to be overlapped and the transparency level of each layer to be controlled. This feature is the first step towards the realization of a three-dimensional virtual excavation reconstruction by the integration of stereophotogrammetric models of the strata instead of orthophotos.

Further improvements are expected as the software is integrated with the new approach of Web 2.0, with its vision of a shared knowledge environment and the building of Distributed Repositories. Future enhancements will also be dedicated to the integration of multilingual programs, 3D data, stratigraphic analysis tools and color management, both by the use of dedicated hardware for acquisition (for example, Pantone Color Cue), and of comparison tables to manage the data in DATARCH (Fabricatore / Cantone 2006b).

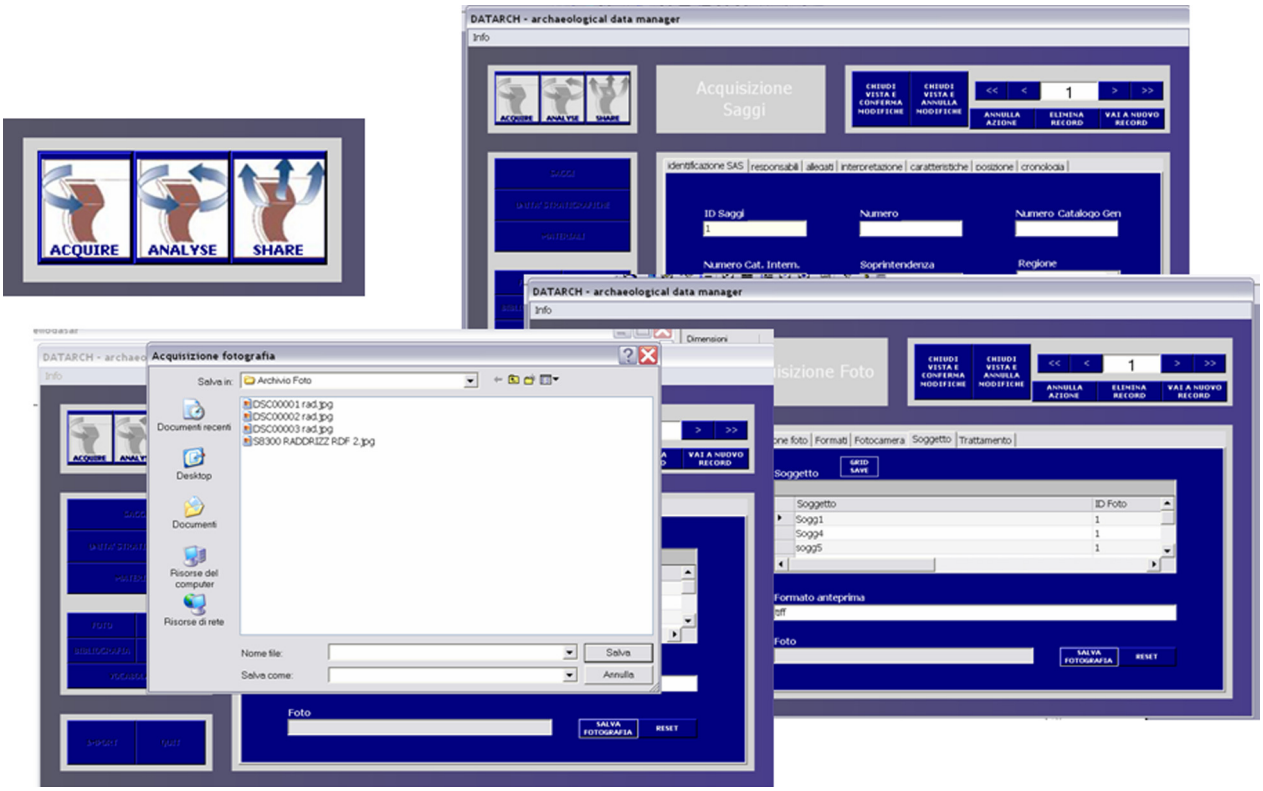

Fig. 4. DATARCH image acquisition interface.

Fig. 5. The "Variable Transparency Image Stacker".

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