NEW WAYS IN DIGITIZATION AND VISUALIZATION OF CULTURAL OBJECTS

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Abstract. Recent developments in 2D and 3D digitization and visualization technologies, as well as in measurement instrumentation, combined with the emerging multimedia databases and network technologies offer today new possibilities for the integrated and complete description of cultural objects. Our Institute, with main interest in the preservation of Cultural Heritage, in an attempt to exploit these new technologies, is developing multimedia databases for cultural objects that include 3D geometric and physicochemical data and are able to be delivered through the Internet. The "Ark of Refugee Heirloom" [1][26] (recording and documentation of unknown heirlooms in the five prefectures of Eastern Macedonia and Thrace that belong to refugees whose origins lay in regions of the Ottoman Empire, south Russia, Bulgaria and others surrounding the Black Sea), is a first generation 3D-database, where, selectively, we have included 3D objects in parallel with their 2D images. "3D-ArCAD" [2][3] (database for archaeological ceramic and glass artifacts with 2D and 3D images, description, typological characteristics, historical information and point-wise surface data), is a second generation 3D-database, where in addition to 2D and 3D images, typological characteristics and historical information, we also include point-wise surface data.

1. INTRODUCTION

The advent of new technologies and their applications revolutionized the way information is stored, archived, retrieved and presented. Their impact on the registration, documentation, presentation and ultimately preservation of Cultural Heritage could be enormous. Systematic recording of the physical and chemical characteristics, typological description and historical information of cultural objects led to the first databases, mainly for research purposes.

Digitization of 2D images of the objects improved the stored information (a picture is always worth a thousand words) and made it more appealing even to the public. Physical and chemical characteristics were still interesting only to a limited number of researchers, but the image combined with historical excerpts in the form of a digital catalog became a standard in promoting private collections and museums. When catalogs described objects to a greater extend and went deeper into scientific facts, they were used also for educational purposes and typological research [11][12].

Multimedia brought a new era with virtual worlds. The relatively simple catalogs, enriched with video and graphics, transformed to virtual museums, while multimedia databases offer now a multitude of information. Still, even today, this wealth of information remains to a great extend bound to a 2D world.

However, great advances in 3D technologies offer today new opportunities to record our Cultural Heritage with high precision, in every detail, and present it in an attractive way where the typical "do not touch" caution, has become a bold "please touch and examine".

It is not only the new imaging methods that help in the documentation and preservation of Cultural Heritage, but innovations in instrumentation give today more accurate, point-wise measurements of physicochemical characteristics and mechanical properties of objects. Combination of such measurements, 3D imaging and mapping provide a field for the development of new ways to register and present information that can revolutionize once again the documentation of Cultural Heritage. The documentation now will be integrated and complete since we have the ability to describe, digitally store, and retrieve the object not only macroscopically, but also in a point-size fashion that enables the virtual reconstruction of the object in every conceivable detail. The effect that such a reconstruction will have upon scientific research, dissemination of the knowledge and public interest is profound. In this contribution, we present two applications developed in out Institute, "The Ark of Refugee Heirloom", a first generation cultural database that simply includes 3D representations of a limited number of cultural objects, and "3D-ArCAD", a scientific cultural database, where point-wise surface data are graphically attached to the 3D objects.

2. THE "ARK OF REFUGEE HEIRLOOMS"[1][26]

A modern information retrieval system mainly requires immediate access to distant stored data, a proper intelligent mechanism to turn raw data into useful information, flexibility to allow users to submit queries of varying complexity, with a number of options, and finally a user-friendly environment.

A crucial technological mean that fulfills most of the above requirements is Internet Databases. The Internet changed dramatically the way we work or conduct our research, since it offers direct access to a vast amount of worldwide distributed information. Databases, on the other hand, are the most suitable structured applications for subject-specific information collection, and can be made available to everyone for general or research-specific purposes. Combining database technology with the Internet we get one of the strongest "weapons" man has ever created in his entire history of evolution. There are many databases with specialized content, providing their services over the Internet, some free of charge, others for a fee. Specifically, a cultural database is a database that can provide with information related to cultural objects, monuments, museums, heirlooms, etc [5].

The "Ark of Refugee Heirloom" (hereafter referenced as the Ark) belongs to this category of cultural databases and concentrates on a special part of Greek Heritage. Its purpose is to document the cultural identity of a particular part of the Greek population that came as refugees due to the population exchange, according to the Lausanne treaty of Jan. 30, 1923 between Greece and Turkey, or emigrated from their motherlands (1922 to 1924). It also serves to distinguish their presence and cultural existence at their origins (expanding beyond the present borders of Greece). In addition, the thorough documentation and publication helps in safeguarding these important and rare items, while offering new possibilities for research and cross-referencing of primary information. It is a novel attempt, undertaken for the first time since these objects were never before recorded systematically and presented to the general public. It is also a venture into culture and technology that will promote the "cultural tourism" in the present living area of this particular segment of the Greek population.

Figure 1. The web-based database user interface

Figure 2. A 3D representation of a cultural object in the Ark

The Ark is a database describing 4.000+ objects (heirlooms), that belong to refugees from North-Eastern Thrace, Constantinople, Black Sea coast, Western Asia Minor, inland of Asia Minor, Southern Pontus and Paflagonia, and finally of Northern, North-Western, and Eastern Pontus. The recording of these heirlooms was a search for primary material, and their tracking and registration was an extremely time-consuming procedure, since these objects were never publicized before and their existence, as well as their sentimental, esthetical and historical value, was known only to their current owners. The database of heirlooms is published on the Internet at the following address (Figure 1):

http://www.ceti.gr/kivotos

In addition to 2Dimages of the objects we have included 3D representations of a limited number of objects. In Figure 2 we show the 3D representation of a selected cultural object, as it appears within the web interface.

The Ark has a twofold importance:

- in terms of scientific research, since the on-site research, recording and presentation of such material, which until recently was not available to most of the researchers, is now widely available to the historic and cultural scientific community and every individual keen for learning. The novelty of the attempt makes the project unique and leading in the sector of cultural data recording. On the other hand, it is a database suitable for further development and future expansion in more refugee settlement regions.
- in terms of its sentimental value for people, who for many social and political reasons lost their country and became the victims of geopolitical changes that happened in the South-Eastern Europe and Asia Minor during the beginning of the 20th century. The Ark is what present day technology has to offer for recording, presentation and ultimately survival of the last remnants of a civilization that flourished through the ages in the regions surrounding Black Sea and in Asia Minor, and finally vanished leaving these remnants as a shelter for the hearts of those reminiscent and in search of the past.

3. THE 3D-ARCAD SYSTEM [2][3]

A second attempt to incorporate latest technologies and methodologies into the integrated documentation of cultural objects is being done in our Institute, with the collaboration of its Archaeometry Laboratory [4], its Multimedia Unit, and the Museum of Avdera, aiming to the development of a multimedia database for archaeological ceramic and glass artifacts. The database will include detailed 2D and 3D images of archaeological finds accompanied by morphological descriptions, historical and scientific data such as dating measurements, mechanical properties and stoichiometric analysis that —where appropriate and possible— will be mapped on the 3D image. Thus, the user-researcher should be able to examine the object from every aspect avoiding at the same time to subject the artifact to any further strain. In addition, the entire object will be stored and be available indefinitely in time and space. The idea is rather revolutionary since presently the majority of the existing databases concerning cultural and historical heritage include only 2D images or drawings of objects and are forced to present several images of different visual aspects in order to provide complete representations. A combination of different technologies was recruited in order to achieve the best possible acquisition of detailed data and interaction between the user and the artifacts, within a 3D environment distributed over a network.

Internet has been acknowledged as one of the most challenging platforms for programming. Java programming language is based on the power of global networks and the idea that the same software should run on many different types of computers and operating systems. A Java application can be easily delivered on the Internet or on any other network. Thus, it is considered as a powerful platform to evolve a 'thin client - thick server' application.

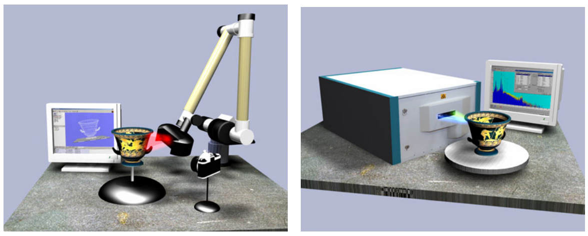
In the late 1960's and 1970's, research on a number of fronts formed the basis of virtual reality as it appears today (e.g. head-mounted displays [9][10], projection-based VR [7][8]). In the mid-1980's, the different technologies that enabled the development of virtual reality converged to create the first true VR systems. The term "Virtual Reality" was originated at 1989 by Jaron Lanier, the founder of VPL Research, defining it as "a computer generated, interactive, three-dimensional environment in which a person is immersed." Since then, virtual reality has captured the public imagination and lots of work has been done to explore the possibilities of virtual reality in new areas of application such as medicine, chemistry, scientific visualization.

Virtual reality is more than just interacting with 3D worlds. By offering presence simulation to users as an interface metaphor, it allows operators to perform tasks on remote real worlds, computer generated worlds or any combination of both. The simulated world does not necessarily have to obey natural laws of behavior. Such a statement makes nearly every area of human activity a candidate for a virtual reality application.

The Virtual Reality Modeling Language (VRML) and Java provide a standardized, portable and platform independent way to render dynamic, interactive 3D scenes across the Internet. Integrating two powerful and portable software languages provides interactive 3D graphics plus complete programming capabilities plus network access [19][20][21][23]. The Web is being extended to three spatial dimensions thanks to VRML, a dynamic 3D scene description language that can include embedded behaviors and camera animation. A rich set of graphics primitives provides with a file format, which can be used to describe a wide variety of 3D scenes and objects. The VRML specification is an International Standards Organization (ISO) specification [24].

One of the most successful applications of VR is in the representation of historical and cultural heritage. The main reason for this success is that in many cases the represented data do no longer exist or are partially destroyed and cannot be viewed in any other way. In addition, the usual photographic (2D) representation often imposes the requirement to present many pictures of an object (taken from a number of different points of view) so as to be able to give viewers a complete description.

In order to implement a system that is able to deliver the virtual reality content of a multimedia database and to use a universal format compatible with most internet browsers, the obvious choice [7][8], today, is to adopt Virtual Reality Modeling Language (VRML) [6]. VRML is a well established solution, with ISO approval and the ability to run in many different Internet browsers. VRML appears to be even more applicable as its file format is supported by many state-of-the-art 3D applications in such a degree that importing and exporting from one application to the other is just a few mouse-clicks away. This file format is fully compatible with the software and hardware our Institute is using for the acquisition of 3D geometry and point-wise surface information from the artifacts. Figure 3 is depicting the 3D scanning and data acquisition procedures.



(a) *(b)*

Figure 3. Representation, at work, of technologies that provide with surface and geometry data,
(a) 3D laser scanner for surface geometry
(b) point chemical composition with a μ-XRF system

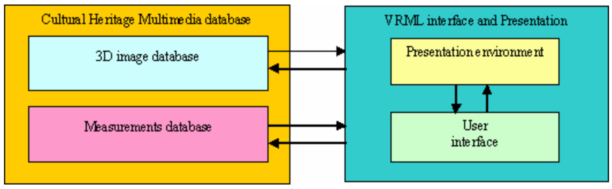


Figure 4. The architecture of the VRML presentation system

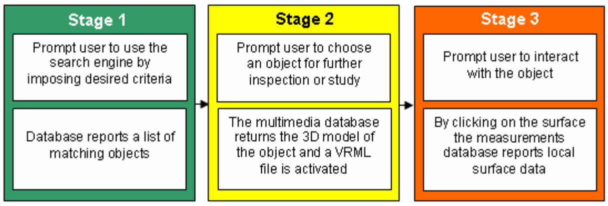


Figure 5. The three-stage system interaction procedure

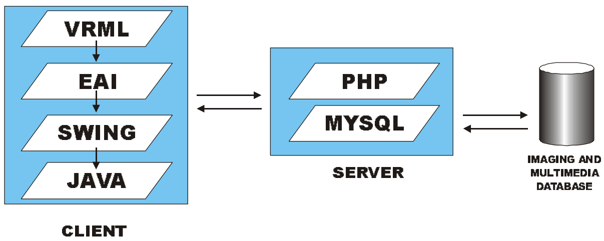


Figure 6. Interaction of different technologies

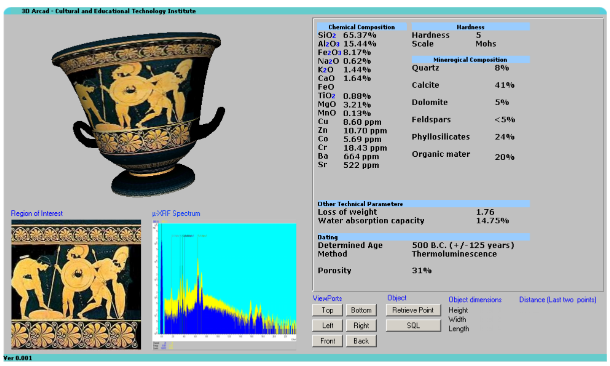


Figure 7. The user interface of the 3D-ArCAD database system

The innovation of our system is that there is no other multimedia database of cultural heritage with 3D data that can be accessed through the internet and also be able to provide with specific point-wise object data. A block diagram of the system is depicted in Figure 4. The block diagram of the work carried out by the system is depicted in Figure 5.

Figure 6 is an illustration of the different technologies involved in our current development. The combination of these technologies gives the ability to the end user to run the client on any Operating System platform. Java is highly supported by Internet browsers and of course VRML plug-ins are freely available over the Internet [13]. In Figure 7 we show the 3D user interface of the application, with both VRML and Java components working in parallel.

4. CONCLUSIONS

Two representative applications of digitization, documentation and presentation of cultural heritage were shown in order to emphasize the possibilities offered by the technologies of yesterday and of today. Now, 2D graphics are being superseded by 3D realistic representations, while immersive environments are becoming the standard for every kind of visualization application. Additionally, advances in measuring instrumentation offer today new potentials in the complete documentation of cultural objects, with the provision of stoichiometric surface data.

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