3D Spatial Measurement Tools for Digitized Artifacts

Can Ozmen and Selim Balcisoy

Sabanci University
Istanbul, Turkey
canozmen@su.sabanciuniv.edu

Abstract

Obtaining and comparing precise measurements–based on real-life spatial relationships of synthesized 3D models based on real-world objects–in an interactive, real-time, virtual environment is an important task. In this paper, we present our work in designing, implementing, and evaluating a set of 3D interactive spatial measurement widgets in the context of a cultural heritage application, V-Stitch, developed for semi-automatic archaeological pottery reconstruction. We have developed a virtual bordimeter, to be used in diameter estimation of reconstructed pottery based on geometric properties of sherds, and a virtual tape measure, to be used in measurement of both the geodesic and planar distances between two points on the surface of a sherd. Although the focus of this paper is on archaeological pottery reconstruction tasks, the 3D measurement tools developed will be useful in other applications in the cultural heritage domain.

1 Introduction

Computer-aided research in the cultural heritage domain benefits from the use of digital models of artifacts. The three-dimensional (3D) data gathered with modern 3D scanning technologies are combined to produce accurate digital representations, which are then commonly used in software applications to visually represent the artifacts in virtual environments. Using accurate digitized models of artifacts is also helpful in restoration, reconstruction, and safeguarding tasks. Cignoni et al. (2006:1) declare investigations of physical measures as one of the opportunities for using 3D models in cultural heritage restoration and safeguarding efforts..

In this paper, we discuss our work and motivation for implementing a set of 3D spatial measurement tools in the context of V-Stitch, a virtual environment for semi-automatic archeological pottery reconstruction. The tools we developed are useful in investigation and analysis of cultural heritage artifacts. Technical details of these tools such as the algorithms used, performance results, and error rates can be found in our ISCIS 2006 publication (Ozmen 2006).

2 Motivations and Related Work

Although the use of digitized models in cultural heritage research is beneficial, the adoption of such techniques is problematic because nearly all experts are trained for using traditional tools on physical artifacts. Both 3D scanning and 3D modeling require familiarity with the hardware and software in order to produce digital models of required accuracy and detail for analysis and visualization tasks. As recent developments in 3D scanning technologies have made the digitization of artifacts affordable, the amount of digitized models available for research have increased rapidly. Consequently, the need for specialized software for cultural heritage research and practice on 3D models has become more apparent.

The problem with using existing 3D modeling software for cultural heritage research on digitized artifacts is that effectively using these programs needs additional expertise with the software and user interface, which the researcher may lack. Such software programs are usually general purpose modeling tools or designed for digital content creation, architecture, or manufacturing and thus do not mimic the traditional way cultural heritage researchers work with artifacts. Therefore, practitioners of the field cannot easily transfer their expertise in the domain to new software tools without further education or specific guidelines (Eiteljog 1988). Applications targeting specific tasks such as archaeological pottery reconstruction exist, but they are limited by their tight focus and cannot be easily extended to other domains in analytical cultural heritage research (Melero 2003:71).

Similar problems arise in the medical field, as well, where the disparity between computer tools and formal education methods is acknowledged. The generally preferred solution to this problem is to present tools with a familiar interface based on their real world counterparts (Preim 2001:31).

3 V-STITCH

We have developed V-Stitch as a virtual environment for semi-automatic archeological pottery reconstruction. It is designed as a 3D visualization application to interface with the reconstruction algorithm in Sagiroglu (2006). Our application uses detailed 3D models digitized from real pottery pieces. It utilizes a bi-manual system: a spaceball and mouse driven user interface that allows the arrangement of the visualized sherds in an intuitive way. It runs in real-time with interactive frame-rates on a common PC.

3.1 Virtual Tape Measure

The virtual tape measure is used for measuring the geodesic

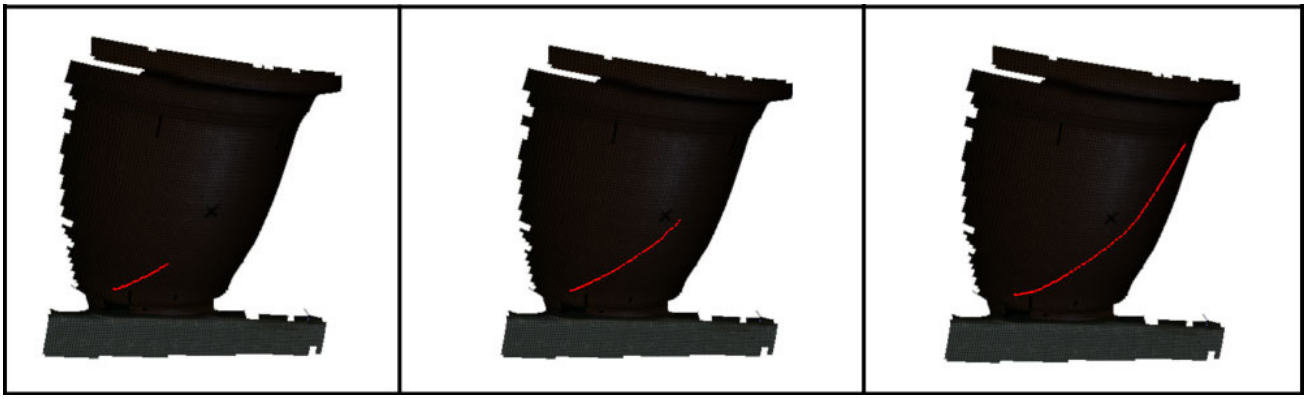

Figure 1. Interactive virtual tape measure at work (left to right).

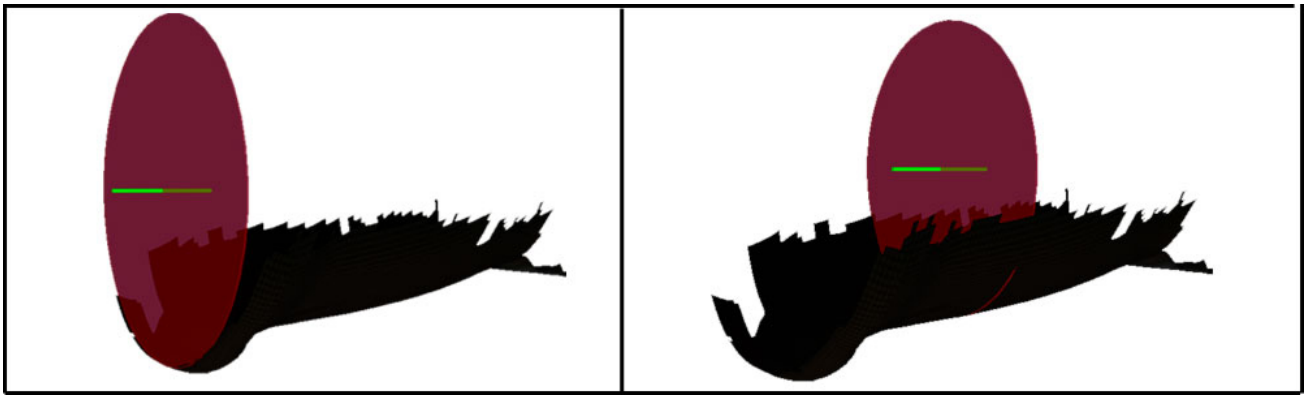

Figure 2. Interactive radius estimation at work (left to right).

distance between two points on the surface of a digitized artifact. In the special case of archaeological pottery reconstruction, rim or fracture lengths can be obtained using the virtual tool, which then aid in the reconstruction task.

3.2 Virtual Bordimeter

The virtual bordimeter is an interactive tool for estimating the radius and center of rotation for a given broken pottery piece. Rim and volume estimations help in the classification of a vessel.

4 Conclusion and Future Work

As future work, we plan to implement new tools specific to cultural heritage research that are lacking in general 3D modeling software packages. We will also conduct a usability test with members of The Archaeological Settlements of Turkey project. Parts of this work can be accessed through the project website at http://graphics.sabanciuniv.edu/chtoolbox/index.html.

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References Cited

Cignoni, Paolo, Callieri, Marco, Scopigno, Roberto, Gori, Giorgio, and Risaliti, Marida. 2006. Beyond manual drafting: a restoration-oriented system. *Journal of Cultural Heritage* 3(7):1-12

Eiteljog, Harrison, II,. 1988. Computer-Assisted Drafting and Design: New Technologies for Old Problems. Updated December 2005, http://csanet.org/inftech/cadbklt.html (Accessed 16 July 2006).

Melero, F. J., Torres, J. C., and Leon, A. 2003. On the interactive 3D reconstruction of Iberian vessels. In, *VAST 2003: 4th International Symposium on Virtual Reality, Archaeology and Intelligent Cultural Heritage.* D. Arnold, A. Chalmers, and F. Niccolucci, eds., pp. 71-78. Brighton: EG Workshop Proceedings.

Ozmen, Can and Balcisoy, Selim. In press. A framework for working with digitized cultural heritage artifacts. In, *ISCIS 2006: Proceedings of the 21st International Symposium on Computer and Information Sciences*. Istanbul, Turkey, November 1-3, 2006. A. Levi, H. Yenigun, E. Savas, S. Balcisoy, Y. Saygin, E. Gelenbe, eds., pp. 394-400 Berlin: Springer

Preim, B., Spindler, W., Oldhafer, K. J., and Peitgen, H.-O. 2001. 3D distance measurements in medical visualizations. In, *Proceedings, Workshop on Interactive Medical Image Visualization and Analysis,* Utrecht, October 18, 2001. S. D. Olabaraggia, W. J. Niessen, and F. Gerritsen, eds., pp. 31-36. Utrecht, Netherlands: Image Science Institute,

Sagiroglu, Mahmut, Ercil, Aytul, and Balcisoy, Selim. 2006. Automated Reconstruction of Archaeological Finds. Paper presented at the Annual Conference of Computer Applications and Quantitative Methods in Archaeology, Fargo, April 18-23.

TAY (The Archaeological Settlements of Turkey) Project. 2006. Home. Updated July 2006, http://www.tayproject.org/enghome.html/ (Accessed 16 July 2006).