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GeoSCAPE: Designing a Reconstructive Tool for Field Archaeological Excavation

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ABSTRACT
We introduce GeoSCAPE, a "reconstructive" tool for capturing measurement data in field archaeology and facilitating a 3D visualization of an excavation rendered in computer graphics. This project is carried out by extending a recently developed an orientation-aware digital measuring tape, called HandSCAPE that has been examined to address the efficiency of bridging measuring and modeling for on-site application areas [2]. In this paper, we present the GeoSCAPE system using the same digital tape measure interacting with an enhancing archaeological-specific 3D visualizations the goal is to provide visual reconstruction methods by acquiring accurate field measurements and visualizing the complex work of an archaeologist during the course of on-site excavation.

Keywords
field archaeology, cognitive activity, reconstructive tool, physical space, tangible interface

INTRODUCTION
Archaeological fieldwork is a cognitive activity because archaeologists virtually reconstruct ancient structures and activities on the basis of chromatic differences, patterns, terrain compositions, shapes and found object. With the advent of computer technology, various tools have been developed to archive and visualize the archaeological sites in 3D graphics. These graphical tools also allow people to navigate the past through interactive views of the site by VRML, QTVR, Quick Time Movie. [1]

How to reconstruct
To reconstruct a virtual model of an archaeological site, archaeologists define the acquisition of excavated data in the field using hand written measurements, notes, and photography. In order to present correct perceptions and hypothesis of the predictive reconstructed models, they interpret the data set outlined follows: artifacts, features, echo-facts, sites and region. The computer reconstructions are used for the presentation of complex information in a visual way allowing models to be progressively tested and refined over the course of an excavation without the destructive means of exploring the site [4].

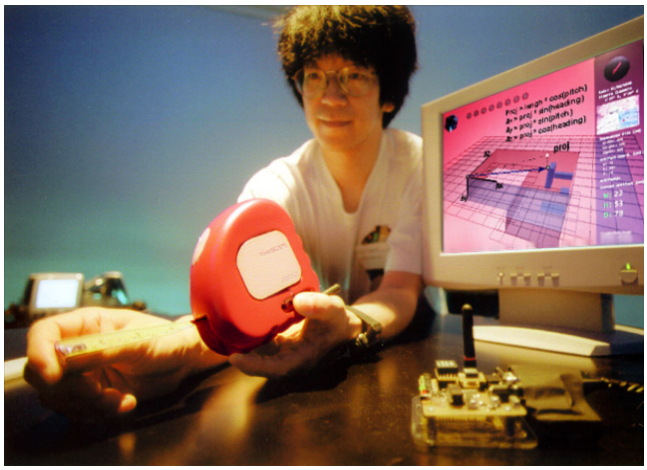

Figure 1. GeoSCAPE system: a digital tape measure interacting with archaeological excavation simulation.

On the other hand, the manner in which an archeological excavation (known as a "dig") is recorded and documented has been left unchanged in recent years. These outdated methods caused the virtual models that often used incorrect reproduction scales. Thus the reconstruction hypothesis could not be properly verified. The next logical step is to design digital technology that enables archaeologists to record and interpret the data efficiently and accurately over the course of the excavation, but in a convenient and natural way, as they dig.

DESIGN IMPLICATION
We presented an initiative step augmenting a traditional measuring tape with a rapid 3D modeling visualization of non-desktop measuring application using HandSCAPE [2]. As one of the on-site applications, we have developed the GeoSCAPE system (Fig. 1). The primary focus was to provide a natural and convenient tool for getting the field measurement data and visualizing them on 3D graphics in real time.

After presenting GeoSCAPE to archaeologists, we have also realized that archaeologists are more interested in integrating the excavated data together with spatial 3D visualizations. Because a site is often destroyed in order to uncover new information, it is very essential to better visualize the progress of excavation on screen.

A RECONSTRUCTIVE TOOL

The input device chosen for this project is HandSCAPE that digitizes field measurements to visualize the magnitude and direction of the resulting vectors with 3D graphics. Using embedded orientation-sensing hardware, it captures relevant vector information on each linear measurement and transmits this data wirelessly to a remote computer in real-time. GeoSCAPE then analyzes this data by using trigonometry to define vector equations in Cartesian coordinates. These vectors are applied to create artifacts in 3D graphics, while the excavation is being performed.

With efficiency and speed, GeoSCAPE allows the user to transmit the relative size and 3D position to a computer. As the user measures arti-facts in real space the representation of the artifacts appear on the computer screen in real time. This synchronicity between measurement retrieval and modeling facilitates analysis of field archaeological excavation.

3D Visualization

During the excavation, three-dimensional spacing is an important factor to be visualized. With GeoSCAPE, the virtual dig has a localized coordinate system centered on one corner of the dig. This is also the "anchor point" defines the relationship between physical space and virtual dig. From the "anchor point", a new reference frame is defined by making a vector in physical space. Within this reference frame, three additional measurements are taken. These are used to define a cubic figure in the virtual space that represents the location of an artifact in the physical excavation [3].

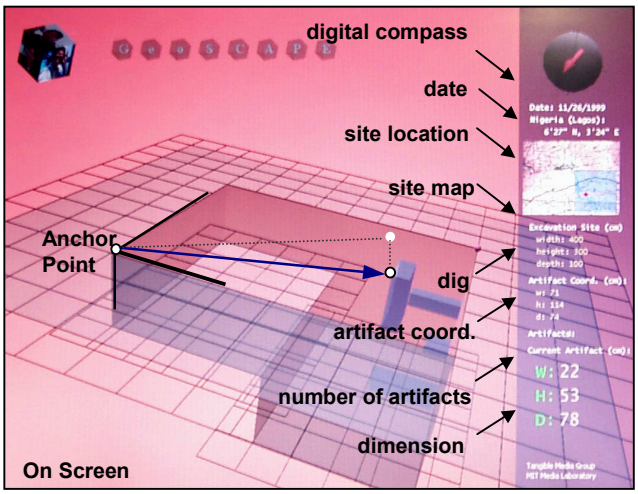

Figure 2 The custom on-screen visualization, running TGS Open Inventor and using customized Visual C++ programs.

The significant improvement of GeoSCAPE is to add an artifact to the dig with relative position and visualize them. The artifact positioning is done by one measurement between the origin of the new reference frame and the "anchor point". In this manner, GeoSCAPE allows a very large number of these artifacts to be defined. Additionally the users can change the location of the "anchor point" to set up their own reference frame in operating a large-scale excavation. While the excavation area is dig further down, the virtual dig extends on the basis of the scale and number of layers included in the dig. Using the same RF frequency, multiple excavators can sequentially input the measurements to perform a collaborative excavation.

Issues of denoting perspective were also important. The compass, seen in the upper right corner of the screen shot (Fig. 3), has its 3D rotation tied to the users movement of the virtual excavation. Other visualizations include a map of the excavated region, excavation dates, the coordinates of artifacts in a dig, dimensions for the artifacts bounding boxes, the ability to create a multi-tier excavation site, and full three-dimensional navigation.

FUTURE WORK and CONCLUSIONS

We are currently working on connecting GeoSCAPE to an archaeological database. This database is used to browse both images and notes linked to each box that represents the artifacts found. We also plan to conduct a field test using GeosCAPE in an actual excavation site since there are numerous demands from archaeologists.

In conclusion, we have presented GeoSCAPE that allows archaeologists with immediate access of information pertinent to the objects being viewed and enabling the excavator to better visualize the site spatially. This timely and accurate result would verify clear interpretations while the excavators obtains increments of information on-site. This new way of using reconstructive tool significantly improves collaboration between on-site and laboratory archaeological research.

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