APPLICATION OF A LOW COST LASER SCANNER FOR ARCHAEOLOGY IN JAPAN.

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ABSTRACT:

In order to use three-dimension data collection in archaeological studies, it is necessary to establish realistic and feasible methods. This report presents our recent trial in Japanese archaeology. Three-dimensional documentation methods have begun to be used in Japanese archaeology. However, these methods are generally expensive. Three-dimensional documentation for archeological studies needs not so much use a highly technical or expensive technology as a realistic and feasible method for documenting artefacts. Therefore, we have experimented in low-cost three-dimension documentation methods for archaeology. Several photogrammetric and laser-scanning tools were tested. The NextEngine Desktop 3D Scanner Model 2020i (NextEngine, Inc.) yielded particularly good results for pottery and roof-tile artefacts. Point clouds data are able to transform and delete easily. These data export a three dimensional drawing with a traditional information. These works show several effects and problems with scanning archaeological artefacts. Most archaeologists in Japan are unable to use three-dimensional data effectively. We have to grope for how to use such data to classify and analyze artefacts. Furthermore, three-dimensional models of archaeological artefacts should be made accessible to the public on-line, and in museums.

1. INTRODUCTION

1.1 Aim of this report

The purpose of this report is to demonstrate a low-cost three-dimensional documentation method in Japanese archaeological studies.

Japanese archaeologists have conducted several archaeological excavations in recent years.
Most of these excavations are rescue excavations and according to the Agency for Cultural Affairs, more than 9500 such excavations were conducted in 2006.
Due to the nature of rescue excavations, however, the resulting archaeological records are difficult to use effectively. In addition, the budget for such excavations is limited.
A great deal of time and resources (both budgetary and human) are spent on making traditional drawings of the uncovered artefacts in the present situation.

Recently, three-dimensional documentation methods have begun to be used in Japanese archaeology.
However, these methods are generally expensive. It has not yet been possible to utilize the advantages of this new technology for archaeological studies.
Undoubtedly, Japanese archaeologists are eager to achieve a solution to the current problem – that is, to have access to more-economical and accessible tools.
Three-dimensional documentation for archeological studies needs not so much use a highly technical or expensive technology as a realistic and feasible method for documenting artefacts.
It is important to compare the new methods with the old, such as hand drawing, photography, and rubbing (which is a traditional recording method used in Asian countries). For example, we must ensure that the employment of new methods for documenting artefacts does not result in the loss of essential information that has been captured in the past using old methods.

Nabunken (Independent Administrative Institution, National Institutes for Cultural Heritage, Nara National Research Institute for Cultural Properties) has experimented in low-cost three-dimension documentation methods for archaeology.

1.2 Related Work

Recently, low-cost three-dimensional documentation methods for historical heritage have been in the spotlight.

Low-cost scanning equipment was examined for effectiveness in documenting archaeological artefacts (Lesk, 2007; Shear, 2008). The NextEngine scanner was reviewed by archaeologists (Abernathy, 2007). DAVID Laser scanner supplies a simple scanning tool for public use (http://www.david-laserscanner.com).
UCSD CISA3 project prosecute Digital Pottery Informatics with low-cost laser scanner (CISA3, 2009). They archive the digital Iron Age ceramics' data using NextEngine scanner.

Useful Open Source Software has been developed, such as Meshlab (http://meshlab.sourceforge.net/), Blender (http://www.blender.org/), and AutoQ3D (http://autoq3d.ecuadra.com/).

The ARC 3D Web service provides an online three-dimensional modelling tool (http://homes.esat.kuleuven.be/~konijn/3d/).

2. METHODS AND RESULTS

2.1 Methods

Several photogrammetric and laser-scanning tools were tested. The NextEngine Desktop 3D Scanner Model 2020i (NextEngine, Inc.) yielded particularly good results for pottery and roof-tile artefacts. (These types of artefacts are common in Japanese archaeological sites.) The NextEngine Scanner is a low-cost laser scanner costing less than $3,000, including turntable and software (figure1).

First, pottery fragments and roof tiles excavated at the Heijyo Capital site (one of the ancient capitals of Japan) were scanned using this scanner. All artefacts were scanned in wide mode (dimensional accuracy is ±0.381 cm/±0.015 inch).
Each piece of scanned data was trimmed, and unified using Align and Fuse command at the ScanstudioHD with RGB texture.

Point clouds data were exported to .STL and .OBJ formats. These data were converted to PDF (PDF-X) file format by Acrobat3D ver.8.0 (Adobe Systems, Inc.).
It is possible to display this PDF file as an orthography projection or a perspective projection under various kinds of lighting conditions.

In addition, to create a bridge between the traditional approach to documentation and the new methods, it is necessary to include a traditional drawing of the artefact in a three dimensional documentation. For example, a pottery surface was drawn on the left side and the profile and inner area was drawn on the right side (This is the traditional way of presenting such information in Japanese archaeology. figure2).

Figure1. Laser Scanning by the Low-cost scanner.

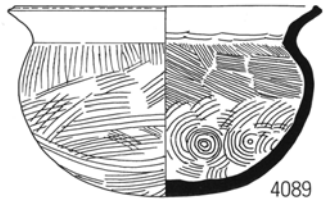

Figure2. The traditional drawing (Haji ware).

Point clouds data are able to transform and delete easily. To output a three dimensional drawing with a traditional information, Point clouds data cut out quarter of a pottery by Meshlab (figure3). This data was converted to a PDF file displayed in the shading illustration mode offered by Acrobat Reader9 (Adobe Systems, Inc.).

2.2 Results

Many methods and types of low-cost equipment capable of capturing three-dimensional data are presently available. This capability is oftentimes more efficient than two-dimensional archaeological drawing.

For decorative artefacts, in particular, our trial demonstrated that it is possible to document artefacts faster using three-dimensional methods, than it is using traditional methods. However, documenting artefacts such as dishes and cups is relatively easy using the traditional methods, but more difficult to document using three-dimensional methods due to the difficulty of aligning scans (as a result of the absence of match

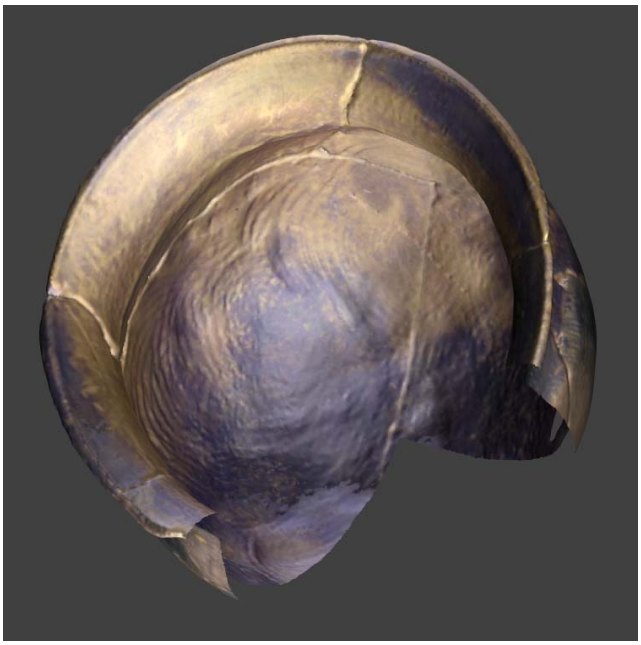

Figure3. Cutting out the model with texture.

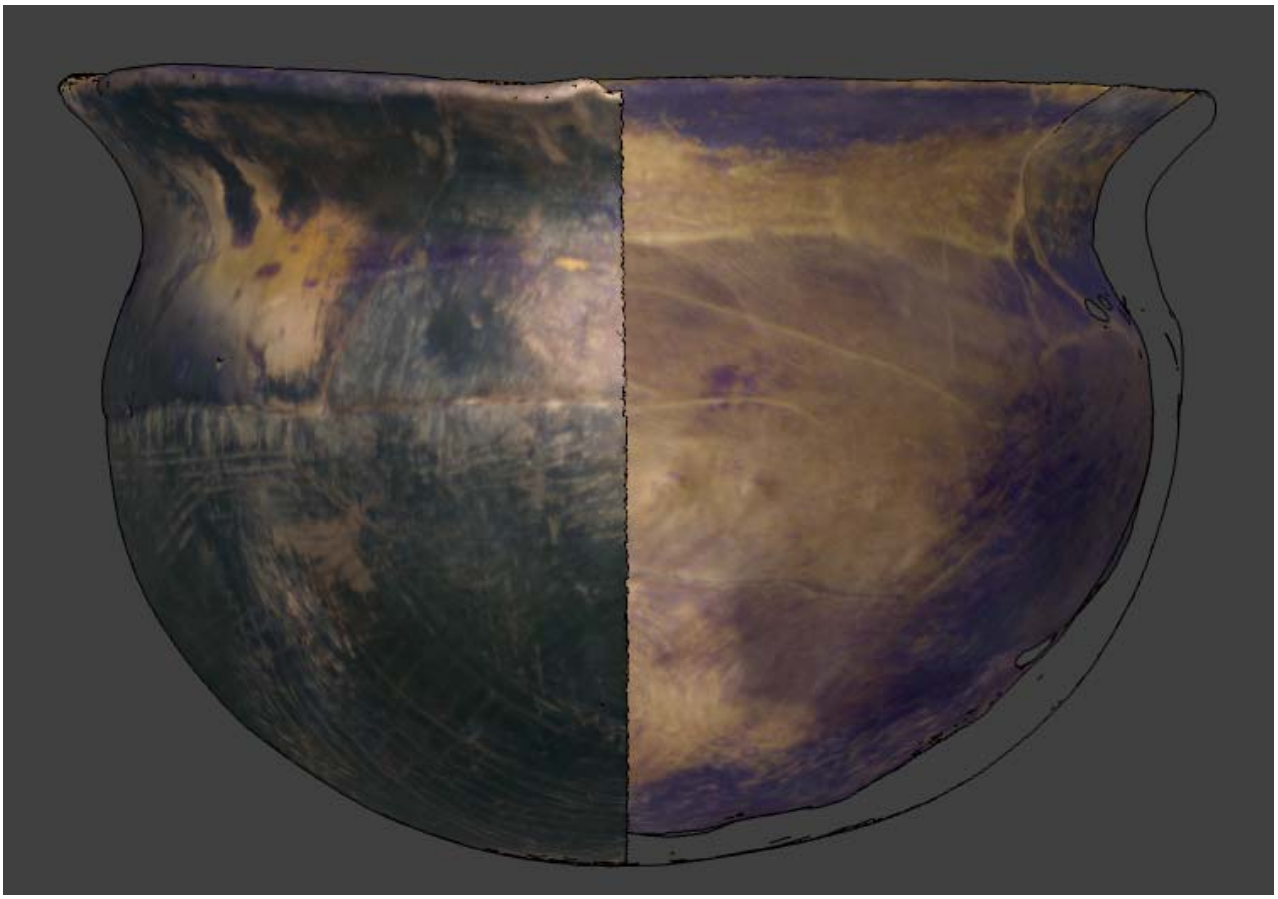

figure4. Shading illustration model from low-cost laserscanner.

points). For example, the rims of pottery are often too narrow to allow for the lining up of match points. I will attempt to find a way to resolve this problem. Possible solutions include the appropriate positioning of artefacts and scanner, the selection of suitable targets, etc.

3. CONCLUSION

In order to use three-dimension data collection in archaeological studies, it is necessary to establish realistic and feasible methods. This report presents our recent trial in Japanese archaeology.
Most archaeologists in Japan (including the author) are unable to use three-dimensional data effectively. It is important, therefore, that archaeologists learn how to use such data to classify and analyze artefacts. For example, pottery and clay figures can be classified by the Fourier descriptor (Iwata and Ukai 2002) under way.

Furthermore, three-dimensional models of archaeological artefacts should be made accessible to the public on-line, and in museums. Our laboratory currently collaborates with archaeologists at local-government level and in foreign countries (such as China) on such projects. For example, PDF-X data generated from Ikoma Kiln sites (8^{th} century A.D.) was presented at an annual exhibition about the excavations by the Ikoma City Board of Education.

Our laboratory will continue to further develop the utilization of three-dimensional data for use in Japanese archaeological studies.

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