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A Study on 3D Modelling Technique for recording archaeological excavation

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Abstract:

Archaeology is considered as a destructive process that includes the accurate detailed site recording which is imperative. At the time of exploration of a site, the documentation is required that helps in recreating and understand the site. Pipeline of 3D modelling can assist archaeologists in the documentation process by building geometrically accurate 3D site model. The process of modelling initiates with the acquisition of data and ends the process using sophisticated visualization tool that is used by researchers for the purpose of exploring and understanding the site. The whole documentation workflow is carried out using digital tools, accuracy and interoperability. This paper discusses the 3D modelling technique which is used for the recording of archaeological excavation and what type of processes are used in this technique.

Keywords: *Archaeological excavation, 3D modelling recording, geometric modelling*

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Introduction

The process of archaeology is basically comprises of various steps such as excavation, archaeological survey, analysis and then the interpretation. At the time of excavation, the archaeological interpretation and the carried out research depends on the collection of data accurately (Paulo et al, 2014). As according to the studies of various researchers, archaeology is a destructive process in which the site analysis requires the structure dismantling, displacement and removal of all the findings that includes tools, bones and pottery. So, it becomes important to keep every accurate record of site when it is being excavated (Allen et al, 2004). In archaeology, the phase of documentation is considered as crucial since the excavations are usually removed from most of the discovered features. First, traditional methods were in use which were majorly manual and they also includes the knowledge about the surveyed object but they consume much of the time and lacks the geometric accuracy. There is one other approach i.e., paper based documentation that provides 2D outputs (Valente et al, 2017). As the three dimensional technique is used in archaeology and from its early time, terrestrial photogrammetry techniques and Computer Aided Design (CAD) is used for the purpose of recording old buildings. For the visualization of archaeological sites or landscapes, Digital Elevation Models (DEM'S) is used whereas for cost surface and viewshed analysis, Geographical Information System is used (https://proceedings.caaconference.org/files/2000/01_Avern_CAA_2000.pdf).

With the increase in usage of more flexible measurements in field work by archaeologists, they should be able to acquire their own measurements in a simple and easy way. The Image based 3D approach of recording offers several kinds of possibilities. After the development of 3D models, Archaeologists use that 3D model for measurement and visualization purposes (Pollefeys, 2003).

3D Modeling – A number of research teams are using the range scans and images that develops 3D models for the purpose of virtual representation of historic sites. Some of the projects that basically involves the modelling of Michelangelo's David, the IBM pieta projects, the Great Buddha project and virtualization of a Byzantine Crypt. In this, archaeological excavation is recorded which is in progress, then track the changes as the excavation process proceeds. And the final step is that these models serve as a complement to documentation. Archaeologists majorly uses photogrammetry instead of range data from laser then scans to create a 3D model. Pollefeys et al, addresses the image based reconstruction for archaeology.

Visualization – Currently archaeologists uses various kinds of documentation (written), sketches, diagrams and photographs which are later used to document the physical state of an excavation site. The documentation process also involves the standard guidelines that are developed especially for this purpose. Both techniques GIS and CAD contain 3D visualization capabilities that presents as layered 2D maps or coarse topographical terrain maps with implanted objects, pictures and sketches. Some of the research groups such as ARCHAVE project that is developed for the purpose of use in CAVE like environment having projected walls and floor. This project comprises of human modeled environment having virtual icons that represents various type of finds and also been sometimes used to determine patterns and trends present on the project found on the site. In contrast, highly detailed computer generated model is used by this system that contains textures of high resolution, accurate representation of the actual site. Gaitatzes et al, stated the virtual reality environments for the temple visualization and public buildings of an ancient Greece (Allen, 2004).

Process of 3D Modelling

Laser range finder and texture is used to acquire the geometry in the form of point clouds.

Scan Acquisition – Laser scanner is used to measure or calculate the distance to points on the site. The scanning data is comprised of print clouds and having each point consists of three (x, y, z) coordinates and representation of amplitude of the laser that is reflected back to the scanner is done using some given values.

Scan registration – For the purpose of completely acquiring a site, multiple scans are required and the resulting point clouds required to be registered together. Then measure the set of control points accurately using GPS and then used in the initialization of a total station in the world coordinate system. After this, the scan the scene at a very low resolution for the purpose to identify and acquiring the position of target in the coordinate system of scanner and helps in solving the 3D to 3D registration problem. Then remove the targets and scan of full resolution is acquired. This technique accurately allows us to register each point individually with the coordinate system of site.

Surface Generation – In this, with the help of registered point clouds, the state of the site at the same

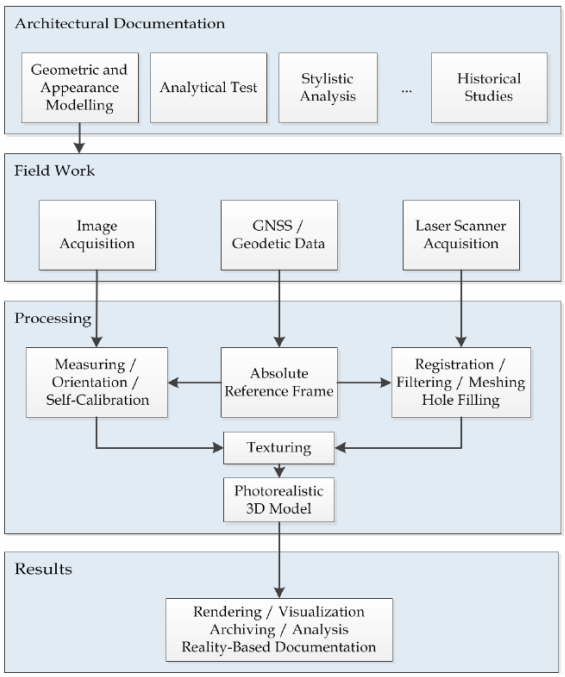
point is represented and generates a triangular mesh surface (Allen, 2004).

According to Fock et al 2017, the pipeline of 3D Modelling is divided into three categories,

- Data Acquisition
- Reconstruction of a computer graphic model
- Visualization and Applications

The captured data of video having marine archaeological sites was gathered using one or two Go Pro Hero 2 cameras. Reconstruction involves image processing, Photogrammetry and then compare the reconstruction results with the traditional one. Lighting and setup test for the purpose of virtual visualization environment is done by loading the reconstruction into Blender, an open source.

For the purpose of recording, drawing, photography and 3D modelling procedures are used. Some of the characteristics of drawing and photography is subjectivity, accuracy, quality, speed, visual representation and utility of data.



3D Acquisition devices

Shape Snatcher that is a system based on the Structured Light Principle which comprises of a program on a CD packaged using a photographic slide and calibration box having 20 cm height. The process initiates with the calibrated image, then the search starts by the software for the grid against the known background of the calibration box. Camera projector system calculates the relevant geometry and then save it as a calibration file. After this, software addresses the subject's image, detects the grid with relation to the calibration file.

Metric 3D reconstruction - In this, the process initiates by the identification of a small number of homologous points in each photograph which are further used to calculate the projective framework. After the refinement process, it becomes possible to search for communications between the every point of the images.

FastSCAN- This process uses laser stripe triangulation for the purpose of range finding and the scanning is performed by operator that sweeps around the subject by hand (Avern, 2000 ; Fock et al,2017).

Review of Literature

As stated by **Avern 2000**, that archaeology uses 3D modelling for the purpose of modelling terrains and artefacts, for constructing virtually buildings and complexes virtually. This paper describes the use of high resolution 3D modelling which is considered as a means of recording excavations.

Pollefeys et al, 2003 explained the 3D recording for Archaeological framework that includes Image based 3D recording. This paper discusses about the applications to archaeological framework which are somehow can help in achieving the future goals.

Allen et al 2004 described the pipeline of 3D modelling that should include new methods for shadow based registration of 2D images. This system of multimodal augmented reality allows the users wearing head tracked and head worn that displays to visualize the model of site and artifacts related to it.

Lambers and Remondino 2007, explained the optical 3D measurement techniques in Archaeology based on the image and range sensors. Three scales of archaeological research are described according to the surveying techniques which are the regional, local and the object scale.

Skarlatos, Demestiha and Kiparissi 2012, explained an open method for 3D modelling and mapping in underwater archaeological sites.In this paper, a novel method uses a combination of photogrammetry and the techniques of computer vision that was utilized through open source software to face the demands.

As stated by **Bernardes et al 2014,** that the tools and techniques of image based 3D modelling tools can be used to support archaeological process. Two different image based modelling tools that results in the 3D models uses the same initial set of digital photos and then these are compared regarding the time that is spent and the accuracy of model.

Skarlatos, Demestiha and Kiparissi 2012, explained an open method for 3D modelling and mapping in underwater archaeological sites.In this paper, a novel method uses a combination of photogrammetry and the techniques of computer vision that was utilized through open source software to face the demands.

Gool et al, explained about the MURALE project which is an IST European project that helps in developing the 3D capture and the technology of visualization for archaeology. He also described the contribution of this project to the enhanced visualization of archaeological sites and finds and also to a faster and more complex documentation to the process of excavations.

According to **Fock et al 2017**, a pipeline is presented to create 3D reconstruction of underwater archaeological sites using the data of video captured by an Autonomous Underwater Vehicle (AUV).

Valente et al 2017, stated the object oriented approach for 3D archaeological d0ocumentation. In this paper, the whole process of documentation is carried out using digital tools, assuring better accuracy. GIS can generate outputs to perform the spatial analysis and is a more effective distribution of fieldworks whose results can assure the database spreading and other type of information using web-services.

Conclusion

According to the study, the high resolution, data dense 3D model is considered as a primary record of an excavation in comparison to traditional drawings that are supplemented by photography.3D modelling is considered to be fast and have more accuracy. It includes more digital data which has greater utility and potential for the other data integration.

The application which are available currently includes speed, accuracy, ease of use, suitability for the field and cost .ShapeSnatcher is from the acquisition dev ices was found to be best in performance for cost. According to this paper it is concluded that the work should be in a ways that it integrates a variety of different data sources, range scans, images, also develop a new technique from image-to-model base registration.

References:

Allen, P, et al. “Seeing into the Past: Creating a 3D Modeling Pipeline for Archaeological Visualization.” 2nd Intl Symp 3D Data Processing, Visualization, and Transmission, IEEE, 2004, www.cs.columbia.edu/~allen/PAPERS/3dpvt04.1.pdf .

Avern, Geoffrey John. “A New Technique for Recording Archaeological Excavations: Research Progress Report.” 2000, pp. 3–7., proceedings.caaconference.org/files/2000/01_Avern_CAA_2000.pdf.

Barsanti, Sara Gonizzi, et al. “Photogrammetry and Laser Scanning for Archaeological Site 3D Modeling - Some Critical Issues.” Https://Pdfs.semanticscholar.org/a7a9/bc732b5dd2d0ca3da138677b72531fb66f65.Pdf, pp. 1–10., pdfs.semanticscholar.org/a7a9/bc732b5dd2d0ca3da138677b72531fb66f65.pdf.

Bernardes, Paulo, et al. “Image-Based 3D Modelling in Archaeology: Application and Evaluation.” *WSCG 2014 Conference on Computer Graphics, Visualization and Computer Vision, 2014*, pp. 159–166., dspace5.zcu.cz/bitstream/11025/11925/1/Bernardes.pdf.

Fock, Sebastian M. T Seibert von, et al. “Pipeline for Reconstruction and Visualization of Underwater Archaeology Sites Using Photogrammetry.” 2017, www.hmc.edu/lair/publications/2017/cata_2017.pdf .

References:

Gool, Luc Van, et al. "The MURALE Project: Image-Based 3D Modeling for Archaeology." www.inf.ethz.ch/personal/pomarc/pubs/VanGoolRS04.pdf .

Lambers, Karsten, and Fabio Remondino. "Optical 3D Measurement Techniques in Archaeology: Recent Developments and Applications." *Konstanzer Online Publications System,* 2008, pp. 27–35.,f-origin.hypotheses.org/wp content/blogs.dir/3124/files/2016/02/Optical_3D_Measurement_Techniques_in_Arc.pdf.

Manferdini, Anna Maria, et al. "3D MODELING AND SEMANTIC CLASSIFICATION OF ARCHAEOLOGICAL FINDS FOR MANAGEMENT AND VISUALIZATION IN 3D ARCHAEOLOGICAL DATABASES." 2008, pp. 1–8., 3dom.fbk.eu/sites/3dom.fbk.eu/files/pdf/VSMM2008_semantic.pdf.

Niknami , Kamal Aldin, and Zahra Mirashe. "3D Tools for Scientific Visualization and Documentation of Archaeological Heritage Case Study: A Sassanid Shrine of Daregaz, Northeastern Iran." *XXI International CIPA Symposium, Jan. 10AD,* www.isprs.org/proceedings/XXXVI/5-C53/papers/FP106.pdf.

Pollefeys, Marc, et al. "3D Recording for Archaeological Fieldwork." *IEEE Computer Society, 2003*, pp. 2–9., www.inf.ethz.ch/personal/pomarc/pubs/PollefeysCGA03.pdf.

Skarlatos, D, et al. "AN 'OPEN' METHOD FOR 3D MODELLING AND MAPPING IN UNDERWATER ARCHAEOLOGICAL SITES." 2012, pp. 1–9., www.ucy.ac.cy/marelab/documents/Mazotos/Anaskafi/Publications_/Skarlatos_Demesticha_Kyparissi_2012.pdf.

Torre, Ignacio de la, et al. "Archaeological Fieldwork Techniques in Stone Age Sites. Some Case Studies." *Treballs d'Arqueologia*, 23 Jan. 2015, pp. 21–40., revistes.uab.cat/treballsarqueologia/article/viewFile/v20-de-la-torre-arroyo-proffitt-etal/51-pdf-en.