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A Study on 3D Modelling Technique for recording archaeological excavation

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Abstract:

Archaeology is considered as a vicious process, which includes the precise thorough site record which is imperative. At the time of exploration of a site, the documentation is required that helps in recreating and understanding the site. Pipeline of 3D modelling can help the archaeologists in a detailed thorough documentation process by constructing geometrically perfect 3D model of the site. The process of modelling initiates with the acquisition of data and ends the process using urbane visualization device that is utilized by researchers and scholars 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 vicious practice in which the spot analysis necessitates the structure disassembling, displacement and removal of all the findings that includes tools, bones and pottery. So, it becomes vital to preserve every exact detail of place while it is being unearthed (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 a variety of scans and images that develop 3D models for a purpose of simulated representation of historical spots. Certain projects basically involve 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 variations as the mining and digging process proceeds. The final step is that these replicas aid as a counterpart to documentation. Archaeologists majorly uses photogrammetry in place of range data from laser than scans to create a 3D replica. Pollefeys et al, addresses the image based reconstruction for archaeology.

Visualization – Currently archaeologists uses different types of documentation (handwritten), sketch drafts, illustrations and pictures which are later used to document the physical condition of an excavated archaeological site. The documentation process also involves the standard guidelines that are developed especially for this purpose. Both the techniques GIS and CAD consist 3D visualization proficiencies that presents as layered 2D maps or abrasive geographical terrain maps with implanted entities, pictures as well as 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 humanly displayed atmosphere having simulated portraits that represents innumerable type of finds and has also been sometimes utilized to determine designs and fashions present on the project located on to the site. In divergence whereas, highly detailed computer generated model is used by this system that contains textures of high resolution, exact exemplification of the actual excavated site. Gaitatzes et al, stated the simulated veracity environments for the temple visualization and civic constructions of an ancient Greece (Allen, 2004).

Process of 3D Modelling

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

Scan Acquisition – Laser scanner is used to measure or calculate the distance to points on the excavated archaeological site. The scanning statistics is comprised of print clouds and having each and every point consisting of three (x, y, z) coordinates and representation of amplitude of the laser, which is replicated back to the scanner using certain given values.

Scan registration – For the purpose of completely acquiring a site, multiple scans are required and the resultant point clouds require to be enumerated together. Then measure the set of control points precisely using GPS and then use in the initialization of a total station in the world coordinated structure.

After this, the scene is scanned at a very minimal resolution for the purpose to recognize and acquire the position of target as per the coordinated system of scanner and thus helps in solving the 3D to 3D cataloguing trouble. Then remove the goals and scan on a full resolution is attained. This method accurately allows us to record each point individually along with the coordinate system of archaeological site.

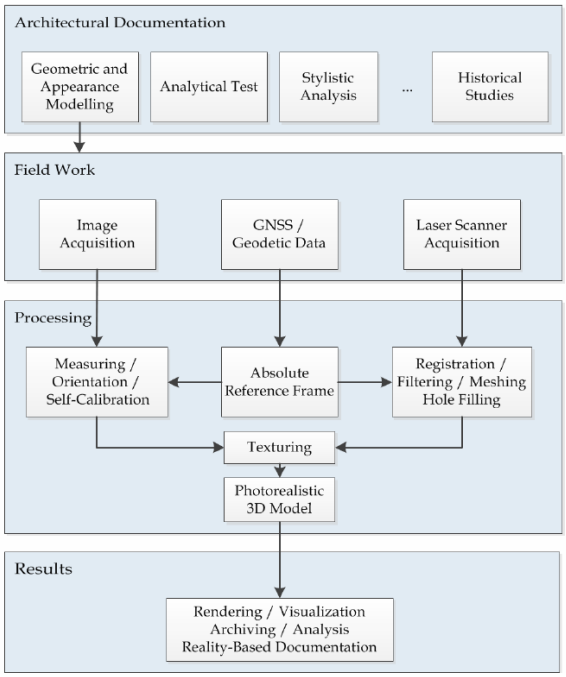
Surface Generation – In this, with the help of the recorded point clouds, the condition and position of the excavated site at the identical point is represented and generates a triangular mesh surface (Allen, 2004).

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 an arrangement based on the Structured Light Principle which comprises of a database on a CD bundled using a detailed photographic slide and calibration box having 20 cms of height. The process initiates with the calibrated image, then the search starts by the software for the network against the identified contextual of the calibration box. Camera projector system calculates the relevant geometry and then saves it as a descriptive calibration file. After this, software reports the subject's image and then detects the grid with relation to the calibration file.

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

FastSCAN- This process accustoms laser stripe triangulation for the purpose of finding range and the scanning thoroughly is performed by worker that sweeps around the concerned 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 multiple use of very high-resolution 3D modelling which is considered as a reliable means of recording excavations at the archaeological sites.

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 fresh means for shadow-based cataloguing of 2D images. This system of multimodal amplified certainty permits the operators wearing head tracked and head worn that exhibits to envisage the model of site and relics related to it.

Lambers and Remondino 2007, explained the optical and visual 3D measurement procedures in Archaeology created on the image and range sensor system. 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 exposed technique for 3D modelling and representing in submerged 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 utilized to sustain archaeological process. Two different image based modelling tools that results in the 3D models uses the equivalent preliminary set of digital photos and then these are associated regarding the time that is expended and the precision of model.

Skarlatos, Demestiha and Kiparissi 2012, explained an exposed process for 3D modelling and plotting in submerged or sunken 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 extraordinary resolution and data dense 3D model is considered as a main data of an excavation in comparison to customary drawings that are complemented by cinematography.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 speediness, exactness, ease to use, appropriateness for the field and the charge .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 assimilates a variation of different sources of data, range scans, as well as images. This also develop a new technique from image-to-model base registration.

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