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USE OF INFORMATION TECHNOLOGY IN ARCHEOLOGICAL RESEARCH: AN OVERVIEW

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Abstract: The current era is characterized by a technological revolution, marked by the rise of social networks, virtual communities, 3D environments, digital applications, and immersive collaborative games. These advancements have the potential to transform our worldview and alter the methods by which information is disseminated and communicated. The transition of society towards innovative technologies has significantly eased the adoption of tools such as Virtual Reality, Augmented Reality, and Photogrammetry in fields like archaeology, which previously faced considerable challenges in integrating such advancements. In recent years, archaeologists have started to utilize cutting-edge technologies to enhance their excavation efforts. These include 3D imaging techniques (such as LiDAR and both mobile and terrestrial 3D scanners), Unmanned Aerial Systems (UAS), and photogrammetry, along with 3D visualization methods (both virtual and augmented reality) for displaying archaeological sites in either three-dimensional or two-dimensional formats. A significant benefit of modern technologies is the rapidly improving capabilities and user-friendliness relative to cost, which motivates archaeologists to explore the burgeoning field of Digital Archaeology. This paper provides an overview of advanced technologies that can aid archaeologists during the excavation process and highlights relevant projects. Additionally, it reviews the existing literature on applications, tools, and software designed for direct use in the excavation field (in situ) to document, manage, and integrate archaeological information, as well as to enhance the exchange, accessibility, and interoperability of scientific data. We are confident that this review will be particularly beneficial for emerging researchers in Digital Archaeology, as it consolidates essential insights from the scientific literature.

Keywords: History, Archeology, Research in Archeology, History and research, Technology, Information technology, Use of IT in archeology

1.0 Introduction

Managing excavation data requires expertise in various interdisciplinary areas, including computer science and archaeology, as well as familiarity with advanced techniques in database design, Geographic Information Systems (GIS), 3D reality modeling, digital reconstruction, and spatial analysis. Over the past twenty years, archaeological research has increasingly adopted innovative technologies to aid in excavation efforts. These technologies include Unmanned Aerial Systems (UAS), photogrammetry, and both virtual and augmented reality, which facilitate the three-dimensional or two-dimensional visualization of archaeological sites. One significant benefit of these technologies is their affordability, which encourages archaeologists to document archaeological sites and landscapes effectively. Today, contemporary 3D research and surveying technologies are routinely employed to enhance data collection and scientific evaluation, offering new methodologies for documentation. In addition, the promotion of cultural assets through reconstruction and the understanding of digital technologies offers effective solutions. 3D visualization and digitization, also known as Reality Modelling, serve as the primary methods for creating digital assets in museums. These technologies are crucial for gathering information necessary for the restoration of historic monuments and sites (Liritzis et al., 2015). The integration of computer science, engineering, mathematics, and natural sciences into archaeological research, both in the field and in educational settings, has been articulated in various ways. Digital archaeology and cultural heritage represent the application of information technology (IT) and digital media, utilizing contemporary technologies in archaeological studies (Hahulina et al., 2019). New terminologies such as Digital Archaeology, Digital Curation, and Cyberarchaeology have emerged in recent times. Cyber-archaeology, a subfield focused on the digital simulation of historical contexts, has gained prominence with rapid advancements (Forte, 2010). This discipline combines cutting-edge developments in computer science, engineering, and the physical sciences to explore anthropological, archaeological, and historical inquiries. It provides techniques for measuring and recording field data, ensuring proper acquisition, analysis, curation, and dissemination of information related to global cultural heritage (Levy et al., 2012, 2018). Notable advancements have been achieved in the intersection of emerging technologies and cultural heritage initiatives, encompassing STEM, STEMAC, cyberarchaeometry, and 3D reconstruction of cultural heritage sites for both research and practical applications. These developments are linked to innovative educational approaches in archaeological science research and higher education frameworks (McCoy and Ladefoged, 2009; Liritzis, 2018; Liritzis and Volonakis, 2021; Liritzis et al., 2015, 2017, 2021a,b; Georgopoulou et al., 2021; Psycharis, 2018; Hatzopoulos et al., 2017). The following sections will introduce relevant past research, detailing methods and applications for each case. This paper aims to review existing technologies that play a crucial role in the digital documentation of archaeological excavations, along with other projects utilizing these technologies. The current review or survey paper in this interdisciplinary domain spans archaeology, cultural studies, computer science, and engineering.

2.0 The Role of Technology in Archaeology

Recent technological advancements have significantly enhanced the discovery and analysis of ancient artifacts and archaeological features. These innovations have become essential to the field of archaeology, transforming research methodologies. Below are five key technological breakthroughs that have made a substantial impact on archaeological practices.

a. Dating

Carbon dating is a precise method for determining the age of organic materials, effective for samples up to around 60,000 years old. This technique involves analyzing the decay of the carbon-14 isotope over time. As reported by UChicago News, the process relies on the principle that all living organisms—such as trees, plants, humans, and animals—absorb carbon-14 during their lifetimes. Upon death, the carbon-14 begins to decay into different atoms. By measuring the remaining carbon-14 in a sample, scientists can estimate the time elapsed since the organism's death. This method was developed in the late 1940s by Willard Libby at the University of Chicago. Although it necessitates testing a sample of archaeological material, carbon dating serves as an effective tool for situating archaeological discoveries within a historical context. Its introduction has revolutionized the field, enabling researchers to date more recent archaeological finds with greater accuracy.

b. CT Scanning

X-ray computed tomography, commonly known as CT scanning, has been utilized for medical applications since 1972. In the realms of archaeology, anthropology, and paleontology, this technique is referred to as "paleoradiology." This non-invasive approach allows for the examination of ancient remains without physical disruption. Specifically, in archaeology, paleoradiology is predominantly employed to analyze mummified bodies. CT scanning produces detailed images of soft tissues, organs, and body cavities, eliminating the need for invasive autopsies. The technology operates by capturing images across multiple radiographic planes, which are then combined to create three-dimensional representations that can be rotated for detailed examination. For instance, CT scans of mummies reveal critical information about the torso and skull, identify bone fractures, and assess the presence or absence of organs, all while preserving the integrity of the specimen.

c. Ground Penetrating

Radar Ground Penetrating Radar (GPR) represents a revolutionary advancement in archaeological methodology. Similar to CT scans, GPR is a non-invasive technique that enables researchers to investigate subsurface conditions. This technology significantly reduces uncertainty in archaeological exploration, allowing for more informed decisions regarding excavation sites and depths. GPR operates by emitting electromagnetic pulses into the ground and analyzing the reflected signals from various subsurface structures. While it does not provide precise images of underground features, it highlights irregularities and general shapes. This capability has proven invaluable for archaeologists in locating structures such as buildings, burial sites, tunnels, and various artifacts. The first GPR system was introduced in 1974 by Geophysical Survey Systems, Inc., which remains a leading provider of this technology. By utilizing existing records and maps to identify potential sites, archaeologists can then employ GPR to accurately target specific excavation areas, enhancing the efficiency of their work.

d. LiDAR

Which stands for Light Detection and Ranging, is a groundbreaking technology that functions similarly to x-ray vision, revealing objects that are otherwise obscured. This technology operates by emitting light pulses towards the ground and calculating the duration it takes for the light to bounce back. From a comprehensive survey, LiDAR creates a detailed virtual 3D map, transforming what used to be a lengthy landscape surveying process into a task that can be completed in just a few hours. It offers millimeter-level precision for topographical mapping, a feat that was nearly inconceivable a few decades ago. The impact of LiDAR on archaeology has been profound, enabling archaeologists to strategically plan excavations and identify sites that would typically go unnoticed. This technology is particularly crucial for uncovering structures concealed by thick vegetation. In Mexico, for instance, nearly 500 new Mesoamerican sites attributed to the Maya and Olmec civilizations have been identified through LiDAR. A notable instance of its application was the 2012 discovery of La Ciudad Perdida in Colombia, which was only authorized for excavation after LiDAR imagery confirmed its presence.

Sodium Phosphate Dating Sodium phosphate dating is an emerging archaeological technique currently undergoing testing, offering a novel approach to DNA extraction from bones and teeth while preserving their integrity. This method entails immersing the artifact in a sodium phosphate solution at progressively higher temperatures, with each increment revealing additional DNA evidence. Developed at the Max Planck Institute in Germany in 2023, researchers applied this solution to a deer tooth pendant discovered in Siberia. They successfully extracted DNA from both the animal and the woman who wore the pendant approximately 18,000 to 25,000 years ago. While the phosphate solution does not provide as precise a timeline as carbon dating, its ability to uncover DNA significantly outperforms many existing archaeological technologies. Elena Essel, a contributor to the method's development, noted in the scientific journal Nature that “sodium phosphate does not dissolve the bone matrix to release the DNA.” By incorporating additional phosphate, it facilitates the “release [of] DNA from the bone matrix without compromising the bone itself.” As technological advancements continue to shape the field of archaeology, new methods are consistently being developed and tested. Participating in an archaeological dig as a citizen scientist offers a unique opportunity to witness these innovative technologies in action.

3.0 Conclusion

Recent technological advancements have led to significant growth in the field of Digital Archaeology, as evidenced by the increasing number of published scientific papers and substantial investments from Departments and Ephorates of Antiquities globally. This progress is largely attributed to innovations in technologies such as 3D Imaging, 3D Data Visualization, and modern mobile technologies that utilize VR and AR modules, which serve as key drivers for digital cultural heritage. This paper aims to provide a concise overview of research related to information technology in archaeological excavation studies and to categorize these efforts based on their primary frameworks, including hardware/equipment, software architecture, or a combination of both. It is important to note that due to the lack of standardization in evaluating the reported studies, it is not appropriate to declare a definitive leader among them. The primary contribution of this paper is to serve as a reference for researchers and IT developers engaged in Digital Archaeology, equipping them with the latest developments in the field and informing system developers about competitive methodologies within the scientific community. To our knowledge, there is currently no review or survey paper that comprehensively covers this interdisciplinary area, which spans archaeology, cultural studies, and computer/information science and engineering. In drawing conclusions from this paper, it is clear that the field of archaeology is well-prepared to integrate emerging technologies, such as virtual and augmented reality, photogrammetry, laser scanning, and advanced IT equipment, as valuable tools in archaeological excavations for managing archaeological findings. The introduction of additional IT excavation management software tools and applications is eagerly awaited, including mobile applications, GIS solutions, and AR/VR headsets and glasses. These innovations aim to integrate advanced technologies to assist professional archaeologists and curators.

4.0 Reference

i. Agugiaro, G., Remondino, F., Girardi, G., von SCHWERIN, J., Richards-Rissetto, H., & de Amicis, R. (2011). Queryarch3D: Querying and visualising 3D models of a Maya archaeological site in a Web-based interface. Geoinformatics FCE CTU, 6, pp. 10-17.

ii. Ardissone, P, Bornaz, L, Degattis, G., Domaine R., (2013). A 3D information system for the documentation of archaeological excavations. ISPRS International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XL-5/W2, pp.55-60.

iii. Benko, H., Ishak, E.W., Feiner, S. Collaborative Mixed Reality Visualization of an Archaeological Excavation, Proceedings of the International Symposium on Mixed and Augmented Reality (ISMAR 2004), pp. 132-140.

iv. Brutto, M. L., & Meli, P. (2012). Computer vision tools for 3D modelling in archaeology. International Journal of Heritage in the Digital Era, 1(1_suppl), pp. 1-6.

v. Chase, A. F., Chase, D. Z., Fisher, C. T., Leisz, S. J., & Weishampel, J. F. (2012). Geospatial revolution and remote sensing LiDAR in Mesoamerican archaeology. Proceedings of the National Academy of Sciences, 109(32), pp. 12916-12921.

vi. Chaumier, S., & Françoise, C. (2014). Museomix: l'invention d'un musée du XXIe siècle. La Lettre de l'OCIM. Musées, Patrimoine et Culture scientifiques et techniques, 156, pp. 7-11.

vii. Conyers L.B. (2014) Interpreting Ground-Penetrating Radar for Archaeology. Routledge, Taylor and Francis Group; New York, NY, USA, p. 214.

viii. Cosmas, J., Itegaki, T., Green, D., Grabczewski, E., Weimer, F., Van Gool, L., Kampel, M. (2001). 3D MURALE:A multimedia system for archaeology. In: Proceedings of the 2001 conference on Virtual reality, archaeology, and cultural heritage, pp. 297- 306.

ix. Deliyiannis, I., Papaioannou, G (2014) Augmented reality for archaeological environments on mobile devices: a novel open framework. Mediterranean Archaeology and Archaeometry, Vol. 14, No 4, pp. 1-10.