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The Importance of Digital Technologies in Studying the Ancient Sites of The Surkhan Valley

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Abstract: The Surkhan Valley in Uzbekistan is a significant archaeological region rich in ancient sites that offer valuable insights into Central Asian history. The integration of digital technologies has transformed the study and preservation of these archaeological treasures. This article explores the impact of digital tools such as 3D laser scanning, photogrammetry, GIS, and remote sensing on documenting, reconstructing, and analyzing the ancient sites of the Surkhan Valley. These technologies facilitate precise recording, virtual visualization, and non-invasive exploration, ensuring the protection and accessibility of cultural heritage for future generations. Additionally, digital platforms enhance public engagement and educational outreach, fostering a broader appreciation of the region's historical significance. The paper underscores the crucial role of digital innovations in advancing archaeological research and heritage conservation in the Surkhan Valley.

Keywords: Digital technologies, Surkhan Valley, archaeological heritage, 3D laser scanning, photogrammetry, GIS, virtual reconstruction, heritage preservation, remote sensing, cultural tourism.

Introduction: The integration of scientific advancements achieved through technological development into the educational process and scientific research remains one of the most pressing challenges facing the science and education systems today.

The study of ancient material culture is a cornerstone of archaeological research, providing insights into the lives, traditions, and societal structures of past civilizations. The Surkhan Valley, located in southern Uzbekistan, is a region rich in archaeological heritage,

with significant remnants of Bronze Age settlements, artifacts, and architectural complexes [1]. Over the years, traditional methods such as excavation, cataloging, and manual analysis have been instrumental in understanding this ancient civilization. However, the advent of digital technologies has revolutionized the field of archaeology, offering innovative tools to enhance the efficiency, accuracy, and depth of research. This report explores the importance of digital technologies in studying the ancient material culture of the Surkhan Valley.

International experiences highlight the importance of incorporating modern technological innovations into archaeological research. These advancements are particularly relevant to the study of Uzbekistan's archaeology, where the material culture of the Bronze Age in the Surkhan Valley has been extensively studied. Information technologies play a pivotal role in this regard, offering new opportunities for data management, visualization, and interpretation.

In the field of archaeology, it is possible to utilize a number of opportunities offered by modern information technologies. Below, we will briefly discuss some of them.

Digital Databases for Archaeological Data. One of the most significant contributions of digital technology to archaeology is the creation of electronic databases [2, p. 25]. These databases allow researchers to systematically organize, store, and analyze vast amounts of information related to archaeological findings. In the case of the Surkhan Valley, where extensive excavations have uncovered thousands of artifacts, digital databases provide several advantages, for example Ease of Access: Unlike traditional paper catalogs, electronic databases can be accessed remotely by researchers worldwide, fostering collaboration and knowledge-sharing; Efficient Data Retrieval: Advanced search functions enable archaeologists to quickly locate specific data, such as artifact descriptions, excavation dates, or geographical locations; Data Preservation: Digital storage ensures that valuable information is preserved indefinitely, reducing the risk of loss due to physical degradation. For example, Sanobar Juraeva's project, the "i-tourism" platform, focuses on creating a digital repository of historical, cultural, and ethnographic sites in the Surkhandarya oasis [3].

GIS (Geographic Information Systems) technology. GPS stands for “Global Positioning System” which is a global positioning system consisting of a network of 24 navigation satellites that orbit the Earth. The satellites regularly provide precise time and location information. Using GPS is associated with the application of modern information technologies, primarily based on computer databases and Geographic Information Systems (GIS). GIS is an automated hardware-software complex that collects topographical, geodetic, land, water resources, and other cartographic information about natural and societal objects and events, processes this data, stores it in computer memory, updates it, analyzes it, and allows for further processing [4].

The use of professional GPS devices in archaeology is considered a special remote sensing method of archaeological exploration. Remote sensing refers to identifying specific features of an archaeological object from a certain distance. Currently, one of the most efficient, compact, and cost-effective methods in archaeology is undoubtedly GPS technology. The main tasks of GPS include collecting, verifying, and analyzing data. Depending on their characteristics, GPS systems are divided into two types: 1) navigational receivers, and 2) geodetic precision systems [5]. The first type ensures the determination of the current stable coordinates of a particular object, allowing you to locate your position on the Earth's surface with an accuracy of up to 15 meters. These devices are convenient to use, compact, and the time required to acquire coordinates can take just a few seconds or minutes. Although geodetic GPS systems are relatively complex devices, they have the ability to determine the location of an object with an error margin of only a few centimeters [6]. In the territory of Uzbekistan, Uzbekistan-Japan (K. Kyudzo, B.A. Turgunov, Sh. Pidaev), Uzbekistan-Germany (Sh. Shaydullaev, D. Huff, K. Kaniut), Uzbekistan-France (P. Leriche, Sh. Rakhmonov, T. Annaev, Sh. Pidaev), Uzbekistan-Russia (E. Rtveladze, J. Ilyasov, T. Mkrtichyev, S. Bolelov, N. Dvurechenskaya), Uzbekistan-Czech Republic (K. Abdullaev, A. Shaydullaev, L. Stancho), Uzbekistan-China (Wu Xin, V. Sverchkov, N. Boroffka), and other similar international expeditions, both local and foreign archaeologists were extensively utilized modern technologies [7]. It is worth noting that the use of new techniques and technologies during these expeditions has brought certain innovations to the archaeology and history of Uzbekistan. In this regard, it is possible to mention the use of GIS technology and note that the number of monuments in the Sherobod district of Surkhandarya region has exceeded 200 [8].

Today, many GIS systems are employed in scientific research and practical activities, among which personal GIS systems are widespread. Examples include GeoDraw GeoGraph (Russia), AtlasGis and WinGis (USA), ArcInfo, MapInfo (USA), and other software programs.

3D (three-dimensional) modeling in archaeology. One of the most important aspects of virtual archaeology is 3D

(three-dimensional) modeling technology. This technology, which provides positive results in many fields, is becoming increasingly popular.

3D modeling is the creation of a three-dimensional project based on an architectural plan, drawing, image, or other sources. With the help of modern computer technologies, it is now possible to reconstruct archaeological sites and ancient architectural structures. Foreign archaeologists extensively use software such as AutoCad, MicroStation, AutoCad Map, Easy Cad, 3DsMax, and similar programs. These tools allow archaeologists to effectively recreate three-dimensional models of settlements, architectural structures, and archaeological finds during field research.

In recent years, special attention has been paid in Uzbekistan to the creation of reconstruction models based on 3D modeling technology for archaeological monuments. For instance, a notable project in this regard is the one carried out around the ancient Kampirtepa monument in southern Uzbekistan. This model was reconstructed using specialized software and technological capabilities, based on E.V. Rtveladze's long-term research, and was publicly displayed in August 2019 during the cultural heritage week titled “Uzbekistan – crossroads of civilizations and roads: empires, religion, culture”.

Data obtained as a result of historical and archaeological research has served as the basis for reconstructing three-dimensional models of important monuments from the Bronze and Early Iron Ages, such as Sopollitepa, Jarkutan, Kyzylcha 6, and Talashtepa, which are considered historical and cultural heritage sites. Architectural designs and hand-drawn reconstruction models of these monuments have been featured in a number of books. Based on this data, it is possible to reconstruct not only individual monuments but also the landscape and natural geographic environment [2, p. 112]. The creation of 3D models of archaeological monuments in such a direction holds significant scientific importance. Additionally, such projects play a special role in popularizing ancient history and expanding the tourism potential of the country.

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