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Editorial

Special Issue on 3D Information Technologies in Cultural Heritage Preservation and Popularization—Motivations, Works Overview, and the Future

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1. Introduction

Elements of cultural heritage preservation and popularization are defined in the Convention Concerning the Protection of the World Cultural and Natural Heritage, which came into force in 1975 and obliges United Nations Educational, Scientific and Cultural Organization (UNESCO) member states to protect cultural and natural heritage [1]. This protection applies to the following areas: documentation, protection, reconstruction, restoration, conservation, dissemination, and popularization [1].

Cultural heritage can be endangered by human actions (random or deliberate), forces of nature (floods, fires), or the mere passage of time. Examples of such activities, leading to the loss of elements of cultural heritage, are presented in [1], including such phenomena as [1]: the fire of the Notre-Dame Cathedral in Paris (France), the destruction of the Old Bridge in Mostar by tank fire (Bosnia and Herzegovina), the blowing up of the Temple of Bel in Palmyra (Syria), cannon shelling of Buddha statues in Bamiyan (Afghanistan), the fire of the National Museum in Rio de Janeiro (Brazil), the theft of petroglyphs from southwestern Arizona (USA), the destruction of Patan Durbar Square by earthquake (Nepal), and the natural collapse of the Azure Window in Gozo (Malta). Cases of irretrievable loss of elements of cultural heritage indicate the importance of its protection, including their documentation, but also popularization.

Techniques for documenting the appearance of cultural heritage objects are currently being rapidly developed thanks to information technology (IT). Techniques such as sketching/photographing, manual measurement, or color photography are being replaced by modern IT technologies that enable the construction and use of 3D models.

At present, the following IT technologies are mainly used to obtain data on historical heritage cultural objects [1]:

(a) Photogrammetry;
(b) Scanning using structured light;
(c) Laser scanning.

These technologies are undergoing constant development, both in the field of hardware and software, and in the direction of automating information acquisition regarding objects of historical heritage. The monography [1] presents these technologies, including their parameters and exemplary data-processing software.

The dissemination of information on cultural heritage is now significantly simplified. Thanks to the development of IT, these activities are increasingly facilitated and can be easily implemented. The Internet has become a universal medium for delivering information to a mass audience, with its wide accessibility a consequence of near-universal global access to mobile telephony. As a consequence, the Internet has effectively and inexpensively popularized a very large part of the world's cultural heritage.

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The topic of this Special Issue of the Applied Sciences journal "3D Information Technologies in Cultural Heritage Preservation and Popularization" is related to the interdisciplinary scope of scientific research, combining IT and the area of broadly understood culture. Interdisciplinary research directions in the area of science (i.e., computer science) combined with humanities (i.e., history, archaeology, museology, etc.) are very demanding in terms of carrying out scientific research and publishing results in scientific journals. Thus, a dedicated Special Issue meets the needs of this area of scientific interest.

2. Three-Dimensional Information Technologies in Cultural Heritage

In connection with the above, this Special Issue presents the results of research that applies the latest 3D information technologies to examine broadly understood cultural heritage. Eleven scientific articles have been published after a thorough and competent peer-review process.

The widest group of articles [2–7] are concerned with the 3D information technology techniques and methods that are used to protect and popularize the cultural heritage. Another group of papers [8–11] examine the practical aspects of using information technology to popularize cultural heritage and detect vandalism in the form of graffiti. Article [11], on the other hand, presents the methods used to select 3D scanners.

Neamtu et al. [2] present the results of the digital restoration and documentation of the Imperial Gates from the Wooden Church of Voivodeni in Sălaj County, Romania. The results of research on wooden churches from Transylvania in Romania, which are a unique and representative resource of rural cultural heritage in this region, are presented. Wooden churches are subject to natural degradation, especially as they are abandoned by their owners in favor of modern buildings. The research presented in this article combines XRF (X-ray fluorescence) and FTIR (Fourier transform infrared) spectroscopy, as well as augmented (AR) and virtual reality (VR) technologies.

Barszcz et al. compare two techniques of data acquisition and constructing 3D cultural heritage models [3]. They compare two object-scanning techniques: Structure-from-Motion (SfM) and Structured-light 3D Scanning (SLS). Their research consisted of photographing, using SfM, and scanning, using a special SLS device, the same historic object in the Afrasiyab museum in Samarkand, Uzbekistan. They describe data processing flows for both methods, and conclude that the cheaper and more widely available SfM method allows the construction of 3D models of objects of a sufficient quality to present and disseminate in media.

The article by Emmitt et al. [4] presents their research on a crested helmet from Tomb 1036 from the Casale del Fosso necropolis, Veii, Italy. In the research, the photogrammetry method was used to build a 3D mesh model of the object, as well as the X-ray fluorescence (XRF) method to analyze the helmet material's chemical composition. They visualize multiple XRF analysis results by constructing a 3D model of the helmet, which allows for a more intelligible presentation of data and helps in their interpretation.

The work by Żyła et al. [5] is a systematic review of 3D scanning techniques for historical costumes based on articles from eight databases, covering 2879 studies. The PRISMA protocol was adopted as the methodological basis for their literature research. Their basic conclusions indicate that a very small number of articles are related to the 3D scanning of historical costumes, the most commonly used techniques are photogrammetry and laser scanning, and the basic goals of most projects are to disseminate information about historical costumes.

Skublewska et al. present an innovative method of digitally capturing of folk dances [6]. They use a motion-capture technique and installation, as well as a developed wire model of the human hand, which complements the whole-body model. The above technique captures the movement of a dancer performing the Lazgi dance, which originates from the Khorezm region in Uzbekistan. Their research is one of only a few examples of digitizing intangible cultural heritage, such as dance or folk customs.

Wójcicki et al. use 3D scanning and an algorithm to highlight petroglyph patterns [7]. Their developed software analyzes 3D scans of petroglyphs in Hodjikent, Uzbekistan. They use the Structured-light 3D Scanning (SLS) method to acquire petroglyph data, and after appropriate post-processing, analyze the 3D model using an algorithm and a program developed by the authors. Despite their considerable results when highlighting petroglyph patterns, the authors stress the need to further refine the algorithm.

Merchan et al. [8] attempt to create a catalog of good practices in the use of augmented reality (AR) for the dissemination of rural architectural heritage. After an extensive literature review and based on their own experiences, the authors developed the Decalogue of Good Practices and present its implementation using the example of AR applications at the Archaeological Site "La Matilla" in Badajoz, Spain. They thoroughly describe the scheme of the procedure to produce the proof of concept of the AR application and illustrate its use with specific examples, emphasizing the problem of depopulation in some agricultural regions of Spain, as well as the importance of AR for their dissemination of information.

Comunità et al. [9] and Lim et al. [10] use IT to create 3D sound for cultural heritage. The first paper presents a set of web- and mobile-based applications for the curation and experience of 3D interactive soundscapes and sonic narratives in a cultural heritage context. They also present their methodology for evaluating the effectiveness of using the system to create a soundscape for cultural heritage preservation, including an analysis of soundscape curation and user experience. Their survey results indicate the practical usefulness of their developed platform. The second article (Lim et al. [10]) presents research related to establishing the role of social media in understanding of cultural diversity. A total of 22 representatives from cultural institutions participated in the study. Furthermore, they examined the participants' reception and impressions of a tour of central London, UK, which was supported by a narration emitted with 3D sound.

Choi et al. [11] focus on an automatic graffiti detection system using social networks, GPS, orthomaps, and artificial intelligence methods. The detector's effectiveness is presented using the Church of Agios Nikolaos (Leontariou), Kantza, Greece, as an example.

Beniak et al. explore the problem of selecting devices for the 3D scanning of cultural heritage objects [12], using an analytical hierarchical process (AHP) method to, for example, choose one of eight possible devices. They base their determination of the importance of experts for the assessment on four criteria. Finally, by analyzing the opinion of experts, they perform an objective device selection.

3. Future of 3D Information Technologies in Cultural Heritage

The call for papers for this Special Issue of the journal Applied Sciences has now closed. Despite this, the use of 3D information technology in cultural heritage requires further, increasingly advanced research. IT is becoming progressively more accessible and popular; therefore, contemporary culture and art must keep up with this trend. On the other hand, tools and software are constantly improving, enabling the automation of research and more accurate documentation of cultural heritage.

The editors of Applied Sciences considered this branch of science and IT applications and opened a new Special Issue titled: "3D Information Technologies for Tangible and Intangible Cultural Heritage" (https://www.mdpi.com/journal/applsci/special_issues/information_technologies_cultural_heritage, accessed on 2 December 2022).

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