

Editorial

Editorial for the Special Issue “Advanced Technologies in Digitizing Cultural Heritage”

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The occurrence of cultural disasters, such as the fire damage at the Notre Dame de Paris in 2019 and at the National Museum of Brazil in 2018, and the recent COVID-19 pandemic highlight that the need to digitize cultural heritage is essential. Past efforts, mainly in the context of specific projects, focused on digitizing items and, in some cases, monuments. However, the rich repositories created are not often used in a meaningful manner, and their content is not returned to the public in a way that supports better public understanding and interpretation of and stronger reflection on cultural heritage. In recent years, there have been several systematic efforts to enable the exploitation of such repositories by applying methods of data curation and digitization, which can support the effective access to the exploration, presentation and preservation of millions of digital heritage assets in accordance with the FAIR (Findability, Accessibility, Interoperability, and Reuse, <https://www.go-fair.org/fair-principles/> (accessed on 3 May 2023) principles.

However, a challenge remains within the field to conceptualize, design, and put into practice new applications that realize the potential for substantive and meaningful use (and reuse) of digital assets. Advanced technologies need to be coupled with new concepts and experience design paradigms to promote user engagement with the past through critical reflection and perspective taking, following an inclusive and personalized approach. Current advances in technologies (e.g., linked data, virtual/augmented/extended reality, chatbots, and digital storytelling), when combined with fundamental technological fields, such as artificial intelligence and machine learning, create new opportunities to explore innovative technological solutions for the effective (re)use of digital cultural heritage assets. This Special Issue aims to showcase cutting-edge research in technology-supported cultural heritage, as well as assist in the alignment of these endeavors. In the works presented in the current Special Issue, readers can see different ways that advanced technologies have been used to allow the digitization of cultural heritage for multiple purposes, such as preservation, as well as making cultural heritage relevant to today's societies.

In particular, Zhang and Romainoor [1] focused on traditional Chinese New Year prints and ways not only to preserve them but also to transform them. The tradition of New Year prints feels outdated in modern China and the rich cultural practice of making such prints has reached the brink of disappearance. Advanced methods of digitization allow the modernization and transformation of these prints with the inspiration from pop art, resulting in the creation of new cultural and creative products. Similarly, Učakar et al. [2] used photogrammetry and 3D modeling to scan wooden sculptures which were exhibited outdoors. Such digitization process assists experts in the humanities in the detailed study of sculptures and their original structural identity; it also supports the production of photorealistic renderings, interactive presentations, 3D printed reproductions, jewelry



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interpretations, and interpretive animations. Again, technology allows the transformation of cultural heritage into new 21st century forms. Furthermore, Huang and Pan [3] focused on intangible heritage, such as the Zhuang brocade weaving techniques, and used technology to provide a deeper understanding of such brocades' cultural traits. Multiple brocade samples were used, and a user study that employed eye tracking and recording of emotions showed user reflections on their heritage and revealed the possibilities for further design developments inspired by the Zhuang brocade weaving techniques.

Often, when people view museum items, they do not associate these items with specific values. People might read relevant information provided by a museum; however, the creation of certain value categories might not be offered, leaving visitors with unstructured materials to process. However, values are important since they allow people to process information more efficiently and support meaning-making. In light of this, Goud et al. [4] used a socio-technological framework for the integration of values into the information of museum content. Their results showed that both visitors and experts found the value-enhanced materials very useful for the communication of museum artifacts.

Digitization of cultural heritage is not a new field. For many years, collections of cultural assets have been digitized. An issue that is often raised is how usable these digital collections really are. It is not uncommon that digital collections are not used, mainly because it is not easy to handle them. This issue is becoming increasingly relevant as humanity is filling social media with digital materials, such as photographs and videos, and information extraction is becoming more challenging. For this reason, Ali et al. [5] used digitized newspapers to study historical photographs published in them. They investigated ways to enhance existing metadata and provide geolocalization information for historical photos, thereby facilitating cross-collection linkages.

Digitization of cultural heritage, including the use of 3D scanning technology, also ensures the preservation of materials and establishes an extensive database of items that can be endangered, either because of natural deterioration or because of damage that may be caused by humans and/or nature. Three-dimensional scanned data can also create datasets that will further allow the reconstruction of damaged artifacts, resulting in three-dimensional reconstructions that can be used in virtual/augmented/mixed reality applications [6]. Ma [7] used big data from wooden historical structures and imported them into a game engine, thus preserving historical knowledge and further assisting in the management of future repairs. The work of Ntagiantas et al. [8] explored ways that augmented reality can be used to allow students to participate in cultural experiences and promote collaborative experiences. Moreover, Boboc et al. [9] provided an overview of the use of augmented reality in cultural heritage over the last decade. They identified eight trending topics, including 3D reconstruction of cultural artifacts, digital heritage, virtual museums, user experience, education, tourism, intangible cultural heritage, and gamification. Finally, the work of Theodoropoulos and Antoniou [10] also focused on games and provided an extensive review of the use of virtual reality games in cultural heritage, aiming to analyze issues of current use and reveal potentials for future developments.

From virtual guides or companions in games to mediators of cultural content and engaging facilitators, virtual agents seem to play an important role. The work of Sylaiou and Fidas [11] discussed issues related to virtual agents' optimization and studied ways that they can be used in virtual and mixed reality settings in order to provide a rich cultural experience. Chatbots are also found to enhance visitor experience. Noh and Hong [12] studied the impact of chatbots on people with different learning styles and how chatbots might affect history education in museums. They found differences in the ways that people with different learning styles connect with chatbots and in how visitors change their behavior according to different chatbot models. However, chatbots often fail to provide all the requested knowledge. For this reason, ways to improve chatbots and make them valuable tools for cultural experience were surveyed by Varitimiadis et al. [13]. Their work compared chatbots and chatbot implementation platforms and concluded that chatbot technology will be significantly benefited from developments in artificial intelligence.

They foresee a prominent use of graph-based, distributed, and collaborative multi-chatbot conversational AI systems in museums.

Furthermore, intangible cultural heritage is threatened when the know-how of traditional practices is lost. The preservation of traditional crafts and ways of creating them is not only a romantic idea, but it could be a valuable source of knowledge for sustainable practices, which could inspire or change today's world. Antonya and Butnariu (2022) [14] developed a virtual environment that brings together visual and haptic elements to simulate the functionality of a manual saw as a carpentry tool. Regarding tangible heritage, it is important to review existing digitization techniques and select the best technique each time depending on the material that we need to digitize. For example, Barreau et al. [15] compared different 3D digitization methods to digitize a Mesolithic bone fragment. Micro-computed tomography (μ CT) provided more details than computerized tomography (CT scan). In addition, 3D models generated by μ CT and photogrammetry were combined to provide an accurate and detailed 3D model. Vrettakis et al. [16] proposed a recommendation system for cultural eco-systems that go beyond museum walls to include a larger area than the physical space of a museum building, exploring the concept of a personalized digital ecomuseum. In their proposed ecosystem, visitors can choose points of interest (POIs) and receive personalized content for both tangible and intangible cultural aspects.

Moreover, many residential and urban areas around the world face a similar challenge of having to balance between the preservation of cultural heritage and current building activity. Can building be constructed safely without damaging historical and archaeological locations? Digital technologies can help by combining detailed interactive maps, geospatial information, rich databases, information coming from different sources, and protective legislations in order to support decision making regarding building developments in a certain location. Marian and Iacob [17] presented such a system, which is used by the Romanian Ministry of Culture in order to protect archaeological heritage. Similarly, Trebeleva et al. [18] used geographic information systems and photogrammetry to obtain a complete picture of extensive archaeological sites, such as the cultural landscape of Northwestern Colchis. In this case, digital technology has allowed the study, preservation, and popularization of the site and revealed important details in the landscape.

As technology changes the very nature of human activity, ethical issues emerge regarding the roles of humans and of technology, as well as the implications of using digital technology for the preservation and interpretation of our past. In particular, artificial intelligence has been criticized for its present and future role in human lives, including cultural experiences. Leshkevich and Motozhanets [19] presented the positive and negative consequences of digitization processes, raised ethical issues, and concluded that cultural heritage digitization should be aimed at generating a human-centered future. Apart from challenges, new technologies can also provide significant opportunities that can change the entire cultural sector. Valeonti et al. [20] studied the ways that non-fungible tokens (NFTs) can be exploited by cultural venues since NFTs could generate significant revenue for artists and museums (e.g., an emerging market for cryptographically signed copies of digital images and fund-raising activities).

Moving beyond preservation, new technologies can be applied in a multitude of novel and exciting ways to digitize cultural heritage. Digitization is the first step toward public engagement, reflection, and understanding of the past, thus creating value for citizens as well as for cultural institutions.

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