

Research Article

A Forward-Looking Vision to Employ Artificial Intelligence to Preserve Cultural Heritage

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Abstract

The study aimed to build a forward-looking vision for employing artificial intelligence in preserving cultural heritage, preserving cultural heritage, principles, values, customs and traditions, in light of globalization, technological progress and the dissolution of cultural identity and cultural heritage, through analyzing and reviewing previous research, studies and educational literature during the years (2022/2023). To ensure an integrated forward-looking therapeutic vision according to clear steps to achieve the targeted use of artificial intelligence applications and the sustainability of cultural heritage for future generations. The current study differs from previous studies in the study methodology, as it adopts the analytical approach, and based on previous studies and the theoretical framework, the two researchers built the proposed forward-looking vision for employing artificial intelligence in preserving cultural heritage. This vision included 11 fields that were as follows: digitization, preservation, restoration and preservation, language. Translation, documentation of cultural heritage, archaeological discoveries, virtual and augmented reality, preservation of oral traditions, crowdsourcing data, ethical considerations, global cooperation, education and awareness. In light of the results, the study recommends strengthening cooperation between institutions concerned with preserving cultural heritage and bodies specialized in the field artificial intelligence. This aims to exchange experiences and knowledge and coordinate efforts to apply artificial intelligence in this field. It also recommends developing standards and ethics for the use of artificial intelligence in the field of cultural heritage preservation. This is to ensure the responsible and ethical use of this technology.

Keywords

Artificial Intelligence, Cultural Heritage, Forward-Looking Vision

1. Introduction

Cultural heritage represents the collective memory of societies, embodying their traditions, history, and identity. However, the preservation of cultural heritage faces significant challenges in our rapidly evolving world. From the threats posed by natural disasters and climate change to the ever-present risk of deterioration due to time and neglect, our cultural treasures are under constant jeopardy. To safeguard

these invaluable assets for future generations, it is imperative that we embrace innovative solutions. Artificial intelligence (AI) emerges as a groundbreaking frontier in this pursuit, offering new possibilities to not only conserve but also to revitalize and make accessible our rich cultural heritage. This study embarks on a forward-looking exploration of how AI technologies can be harnessed to safeguard and enhance the

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preservation of our diverse cultural legacies, transcending the boundaries of time and space. In doing so, it seeks to shed light on the transformative potential of AI in the preservation and promotion of cultural heritage, fostering a deeper understanding of the intricate interplay between technology and tradition [7].

2. Study Outline

2.1. Study Problem

This study aimed to invest in artificial intelligence techniques in preserving cultural heritage. The problem of the study is to answer the main question of the study: What is the proposed forward-looking vision for employing artificial intelligence in preserving cultural heritage? The following sub-questions branch out from it:

- 1) What are the most important techniques of artificial intelligence in preserving cultural heritage?
- 2) What is the proposed forward-looking vision to employ artificial intelligence in preserving cultural heritage?
- 3) What is the appropriateness of the proposed outlook for employing artificial intelligence in preserving cultural heritage from the point of view of specialists and experts?

2.2. The Importance of Studying

The importance of the study is divided into two axes:

2.2.1. The Importance of the Study from a Practical and Applied Point of View

- 1) It is hoped that policy makers will benefit from this study by emphasizing the promotion of the principles of cultural heritage and intellectual rights in artificial intelligence to preserve culture and foresee the future.
- 2) It is hoped that the leaders will benefit from the recommendations of this study to play their role in encouraging educators and specialists in the educational process to pay attention to cultural heritage and artificial intelligence.

2.2.2. The Importance of Studying from a Theoretical and Intellectual Point of View

- 1) It is hoped that this study will represent a scientific addition to its subject, which is an urgent need in our current era and from the literature that libraries lack, according to the knowledge of researchers.
- 2) It is hoped that this study will provide scientific and research horizons for other researchers to delve into this field in an effort to bring about the desired development and add new knowledge to educational thought and positive scientific research to bring about the required change.

2.3. Objectives of the Study

- 1) Identify the most important techniques of artificial intelligence in preserving cultural heritage.
- 2) Building the proposed forward-looking vision to employ artificial intelligence in preserving cultural heritage.
- 3) Identify the appropriateness of the proposed view of employing artificial intelligence in preserving cultural heritage from the point of view of specialists and experts.

2.4. Method of the Study

The researchers used the analytical descriptive approach, as well as the theoretical approach by referring to literature and theoretical studies related to the subject. Forming a theory around specialized ideas and concepts in the field of study. reviewing relevant previous studies, by analyzing the literature related to the study; To reach an answer to the study questions and make several recommendations.

3. Study Approach

The researchers used the analytical descriptive approach, as the theoretical approach was used by referring to theoretical literature and studies related to the subject. To form a theory about specialized ideas and concepts in the field of study. and a review of relevant previous studies, by analyzing the literature related to the study; To reach an answer to the study questions and make a number of recommendations.

4. Previous Studies

Jiang, X., Harun, S. N., & Liu, L [1], Study title: Explainable Artificial Intelligence for Ancient Architecture and Lacquer Art, This research investigates the use of explainable artificial intelligence (XAI) in ancient architecture and lacquer art. The aim is to create accurate and interpretable models to reveal these cultural artefacts' underlying design principles and techniques. To achieve this, machine learning and data-driven techniques are employed, which provide new insights into their construction and preservation. The study emphasises the importance of transparent and trustworthy AI systems, which can enhance the reliability and credibility of the results. The developed model outperforms CNN-based emotion recognition and random forest models in all four evaluation metrics, achieving an impressive accuracy of 92%. This research demonstrates the potential of XAI to support the study and conservation of ancient architecture and lacquer art, opening up new avenues for interdisciplinary research and collaboration.

Lee, Shin & Im, [2, 8], Study title: Development of data labelling and visualization technologies for cultural heritage

intelligent curation. Heritage, This study aims to enable users of digitized cultural heritage artefacts to understand the correlation between artefacts and their context, discover new knowledge, and gain inspiration. We have developed data labelling and visualization technologies specific to cultural heritage so that users, such as curators, cultural heritage experts, and museum visitors, can easily and quickly access the information that they want through the correlation between artefacts. We came up with a web-based labelling tool for cultural heritage data and applied it to data on 45,692 artefacts from the National Museum of Korea. We also invented a web-based visualization tool that converts lists of attribute information in Excel spreadsheets into visualized content and edits the attributes. The meanings of thumbnails of visualized cultural heritage and that of connected lines, a search function, and visualized cultural heritage will allow users to quickly and easily access the cultural heritage information they are looking for.'

Pansoni, S., Tiribelli, S., Paolanti, M., Stefano, F. D., Frontoni, E., Malinverni, E. S., & Giovanola, B [3, 9], Study title: Artificial Intelligence And Cultural Heritage: Design And Assessment Of An Ethical Framework. Gottingen, The pioneering use of Artificial Intelligence (AI) in various fields and sectors, and the growing ethical debate about its application have led research centers, public and private institutions to establish ethical guidelines for a trustworthy implementation of these powerful algorithms. Despite the recognized definition of ethical principles for a responsible or trustworthy use of AI, there is a lack of a sector-specific perspective that highlights the ethical risks and opportunities for different areas of application, especially in the field of Cultural Heritage (CH). In fact, there is still a lack of formal frameworks that evaluate the algorithms' adherence to the ethical standards set by the European Union for the use of AI in protecting CH and its inherent value. Because of this, it is necessary to investigate a different sectoral viewpoint to supplement the widely used horizontal approach. This paper represents a first attempt to design an ethical framework to embody AI in CH conservation practises to assess various risks arising from the use of AI in the field of CH. The contribution presents a synthesis of the different AI applications to improve the preservation process of CH. It explores and analyses in depth the ethical challenges and opportunities presented by the use of AI to improve CH preservation. In addition, the study aims to design an ethical framework of principles to assess the application of this ground-breaking technology at CH.

Der-Lor, W., & Yu-Hsien, W [4, 13], Study title: Use of cloud-based virtual reality in chinese glove puppetry to preserve intangible cultural heritage. Chinese traditional glove puppetry is a folk art with a long history. It is worth inheriting and safeguarding this distinguished intangible cultural traditional art using virtual reality. With this background, this study integrates the digital resources of glove puppetry from the perspective of satisfying users' performance needs. In

this study, a multi-user, cloud-based virtual reality glove puppetry system was developed that enhances the classic works of glove puppetry. Each user has a unique perception of the virtual environment and can interact remotely. The system involves human-computer and human-human interactions. This study also describes the design and control of glove puppets. The virtual reality system provides a unique entertainment experience to users of all ages. Through a questionnaire administered to 30 subjects after the user play, this study investigated the operation and experience of this system. According to the research findings, the proposed cloud-based VR system is not only easy to use, but also helps to preserve traditional intangible culture. Our research has high theoretical value and can help preserve traditional glove puppetry. Our cloud-based virtual reality system offers a new application for disseminating and preserving intangible cultural heritage.

Croce, V., Caroti, G., Piemonte, A., De Luca, L., & V éron, P. [5, 12], Study title: H-BIM and artificial intelligence: Classification of architectural heritage for semi-automatic scan-to-BIM reconstruction. Sensors, We propose a semi-automatic Scan-to-BIM reconstruction approach, making the most of Artificial Intelligence (AI) techniques, for the classification of digital architectural heritage data. Nowadays, Heritage- or Historic-Building Information Modeling (H-BIM) reconstruction from laser scanning or photogrammetric surveys is a manual, time-consuming, overly subjective process, but the emergence of AI techniques, applied to the realm of existing architectural heritage, is offering new ways to interpret, process and elaborate raw digital surveying data, as point clouds. The proposed methodological approach for higher-level automation in Scan-to-BIM reconstruction is threaded as follows: (i) semantic segmentation via Random Forest and import of annotated data in 3D modeling environment, broken down class by class; (ii) reconstruction of template geometries of classes of architectural elements; (iii) propagation of template reconstructed geometries to all elements belonging to a typological class. Visual Programming Languages (VPLs) and reference to architectural treatises are leveraged for the Scan-to-BIM reconstruction. The approach is tested on several significant heritage sites in the Tuscan territory, including charterhouses and museums. The results suggest the replicability of the approach to other case studies, built in different periods, with different construction techniques or under different states of conservation.

Lee, B. C. G. [7, 10], Study title: Human-AI interaction for exploratory search & recommender systems with application to cultural heritage Exploratory search and recommender systems are ubiquitous and central to information navigation. Yet, many pressing challenges remain surrounding the development of robust systems, from producing high-quality data and etadata to answering fundamental questions in human-AI interaction concerning the interactive affordances for search and recommendation. These challenges are exacerbated by 1) the ever-expanding wealth of information to be

searched, and 2) the widespread incorporation of increasingly opaque and complex machine learning models into deployed systems. This thesis explores these challenges and investigates how we can improve interaction mechanisms in exploratory search and recommendation. Much of this dissertation adopts the setting of digital cultural heritage collections, where impoverished metadata redoubles challenges of searchability, with implications across disciplines. This dissertation introduces three primary contributions through publicly deployed systems and datasets. First, we demonstrate how the construction of large-scale cultural heritage datasets using machine learning can answer interdisciplinary questions in library & information science and the humanities (Chapter 2). Second, based on the feedback of users of these cultural heritage datasets, we introduce open faceted search, an extension of faceted search that leverages human-AI interaction affordances to empower users to define their own facets in an open domain fashion (Chapter 3). Third, encountering similar challenges with the deluge of scientific papers, we explore the question of how to improve recommender systems through human-AI interaction and tackle the broad challenge of advice taking for opaque machine learners.

Zhang, B., & Nurul, H. R. [6, 11], Study title: Research on artificial intelligence in new year prints: The application of the generated pop art style images on cultural and creative products. Chinese New Year prints constitute a significant component of the country's cultural heritage and folk art. Yangliuqing New Year prints are the most important and widely circulated of all the different kinds of New Year prints. Due to a variety of factors including societal change, industrial structure change, and economic development, New Year prints, which were deeply rooted in agricultural society, have been adversely impacted, and have even reached the brink of disappearance. With the protection and effort from the government and researchers, New Year prints can finally be preserved. However, the underlying problems remain, such as receiving little attention, a singular product form, and being unable to keep up with the times, especially among the younger generation. In this paper, the researchers first processed Yangliuqing New Year prints through the GANs model. Then, the image is segmented by binarization and color extraction of images from the Pop art dataset by the K-Means algorithm, followed by colorizing the binarized and segmented image. Finally, usable high-quality Pop art style Yangliuqing New Year prints are generated. The generated images are used in the development of cultural and creative products. Questionnaires were then distributed based on the empirical research scale. The results of this study are as follows: 1. The method proposed in this study can generate high-quality Pop art style New Year prints. 2 Using Pop art style New Year print images in the design of cultural and creative products is popular among the younger generation, and they possess a great propensity to purchase. This study solves the problems encountered by the current cultural her-

itage of New Year prints, and broadens the artistic expression forms and product categories, and provides research ideas for the cultural heritage of the same type that is facing similar problems. In the future, researchers will continue to explore the incorporation of AI technology in New Year prints to stimulate the vitality of traditional cultural heritage.

Results:

First: the results related to the first question" What are the most important techniques of artificial intelligence in preserving cultural heritage?

Referring to previous studies to answer the question about intelligence techniques Artificial materials play a crucial role in the preservation of cultural heritage as a study Lee, B. C. G. (2023). as a study Zhang, B., & Nurul, H. R. (2023). a study Lee, Shin & Im, (2023). Preserving cultural heritage through artificial intelligence (AI) involves various techniques and approaches. Here are some of the most important ones:

- 1) Image Analysis and Recognition: AI can be used to analyze and recognize images, which is crucial for cataloging and identifying artifacts, artworks, and historical documents. This includes techniques like object detection, image classification, and image segmentation.
- 2) Natural Language Processing (NLP): NLP techniques are used to transcribe, translate, and analyze textual content related to cultural heritage, such as historical documents, manuscripts, and inscriptions. NLP can also help in creating multilingual databases for wider accessibility.
- 3) Machine Learning for Content Recommendation**: AI-driven recommendation systems can suggest culturally relevant content to users based on their preferences, promoting engagement with cultural heritage materials.
- 4) 3D Scanning and Modeling**: AI can aid in creating detailed 3D models of artifacts, historical sites, and buildings. This allows for virtual exploration and preservation of cultural heritage in a digital format.
- 5) Data Mining and Pattern Recognition**: AI can assist in uncovering hidden patterns and trends within cultural heritage data, enabling historians and researchers to gain new insights and knowledge.
- 6) Computer Vision for Restoration**: AI can help restore damaged artworks and documents by filling in missing parts, reducing cracks, and enhancing colors. This is particularly valuable for preserving deteriorating items.
- 7) Geographic Information Systems (GIS)**: GIS technology combined with AI can help in mapping and managing cultural heritage sites, monitoring environmental changes, and mitigating risks like natural disasters or climate change.
- 8) Augmented Reality (AR) and Virtual Reality (VR)**: AR and VR technologies offer immersive experiences, allowing users to virtually explore historical sites or

interact with cultural artifacts, making heritage more engaging and accessible.

- 9) **Robotics and Drones****: Robots and drones equipped with AI can be used for site inspections, maintenance, and surveillance, reducing the risk of theft or vandalism at heritage sites.
- 10) **Predictive Analytics****: AI can predict potential threats to cultural heritage, such as the impact of climate change, allowing for proactive conservation efforts.
- 11) **Preservation Metadata****: AI can help manage and organize metadata related to cultural artifacts and documents, ensuring that essential information is preserved alongside the items themselves.
- 12) **Crowdsourced Content****: AI can assist in aggregating and curating user-generated content related to cultural heritage, fostering community involvement and knowledge-sharing.

- 13) **Authentication and Fraud Detection****: AI can aid in authenticating artifacts and identifying fraudulent activities in the art market, helping to preserve the integrity of cultural heritage collections.

Second: Results related to the second question" What is the proposed forward-looking vision to employ artificial intelligence in preserving cultural heritage?

To answer this question, we referred to previous studies to reconstruct a proposed forward-looking vision for employing artificial intelligence in preserving cultural heritage as a study. Zhang, B., & Nurul, H. R. (2023). Lee, B. C. G. (2023). as a study Der-Lor, W., & Yu-Hsien, W. (2023). The proposed forward-looking vision for employing artificial intelligence (AI) in preserving cultural heritage is multifaceted and revolves around leveraging AI technologies to protect, document, restore, and share cultural artifacts and traditions. This vision encompasses various aspects:

Table 1. *The proposed forward-looking vision to employ artificial intelligence in preserving cultural heritage.*

Field of view	Field of view application
Digitization and Preservation	AI can be used to digitize and archive cultural artifacts, documents, and historical records. High-resolution scanning, image recognition, and natural language processing (NLP) can help preserve delicate materials, making them accessible to future generations.
Restoration and Conservation	AI algorithms, such as computer vision and deep learning, can assist in the restoration and conservation of artworks, historical buildings, and archaeological sites. They can help identify damage, propose restoration techniques, and even simulate the aging process to anticipate future conservation needs.
Language and Translation	Language-related AI tools, like machine translation and sentiment analysis, can aid in translating and preserving languages that are endangered or not widely spoken. This is crucial for maintaining linguistic diversity and understanding ancient texts.
Cultural Heritage Documentation	AI can automate the process of cataloging and documenting cultural artifacts and historical sites. This includes image recognition for categorizing items, extracting metadata, and generating detailed descriptions.
Archaeological Discoveries	AI and drones can assist archaeologists in surveying and mapping archaeological sites, helping to uncover hidden treasures and streamline the excavation process.
Virtual and Augmented Reality	AI-driven VR and AR experiences can offer immersive ways for people to explore and interact with cultural heritage. This can include virtual tours of historical sites, interactive museum exhibits, or even recreations of lost historical moments.
Preservation of Oral Traditions	AI can be employed to transcribe and translate oral traditions, songs, and stories, helping to preserve and share indigenous and oral cultures.
Crowdsourced Data:	AI can facilitate the collection of data and information from the public, allowing individuals to contribute to the preservation and documentation of their own cultural heritage.
Ethical Considerations	The forward-looking vision must also address ethical concerns, including issues related to data privacy, cultural sensitivity, and the potential for AI to inadvertently perpetuate biases.
Global Collaboration	International cooperation and the sharing of AI-driven tools, resources, and best practices can accelerate the preservation of cultural heritage on a global scale.
Education and Awareness	AI-powered educational tools can help raise awareness about the importance of cultural heritage preservation and engage younger generations in understanding and appreciating their cultural history

5. Conclusion

1. Enhancing cooperation between institutions concerned with preserving cultural heritage and specialized agencies in the field of artificial intelligence. This is in order to exchange experiences and knowledge and coordinate efforts to apply artificial intelligence in this field.
2. Developing standards and ethics for the use of artificial intelligence in the field of preserving cultural heritage. This is to ensure the responsible and ethical use of this technology.
3. Conducting more research and studies on the applications of artificial intelligence in the field of preserving cultural heritage. This is to identify areas where AI can bring significant benefits.

Conflicts of Interest

The authors declare no conflicts of interest.

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