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Research Article

PRESERVING THE CULTURAL LANDSCAPE IN THE CONTEXT OF MEMORY AND ARTIFICIAL INTELLIGENCE

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ABSTRACT. The preservation of cultural landscapes and their transmission to future generations through collective memory has emerged as a prominent area of research. With the advent of artificial intelligence technologies, scholars have increasingly focused on projects exploring the integration of AI into cultural heritage and memory studies. The contributions of this technology to preservation practices may play a vital role in sustaining cultural values and ensuring their continuity for future generations. While developments in preservation provide new tools for cultural transmission, they also raise significant ethical and social questions. The research problem of this study concerns the preservation of cultural heritage and memory within the context of cultural landscapes, the sensitivity required in their intersection with AI technologies, and the transmission of these themes. The aim is to contribute to the understanding of how advancing AI technologies may transform the collective memory directly connected to elements of the cultural landscape, and what implications this transformation might have for the future of these landscapes. In particular, the study examines the potential contributions of AI to the shaping of cultural and historical urban fabrics through selected examples. Within the framework of cultural landscape studies, the theoretical background of memory and artificial intelligence is discussed, and examples illustrating AI's functions and areas of application in cultural research are presented. The study also addresses the general ethical and social challenges that may arise from the use of AI in cultural heritage projects, as well as possible innovations enabled by future advances in AI technologies.

Keywords: cultural landscape, memory, artifical intelligence, digital preservation

INTRODUCTION

The concept of memory is increasingly being used in research to understand and preserve cultural landscapes and to leave heritage sites for future generations. Artificial intelligence is emerging as a new method among these tools, driven by the exploration of new tools and methods. The contributions of artificial intelligence to conservation efforts can play a significant role in the preservation of cultural values and the transmission between generations. Although AI is a relatively new and evolving technology, its use in archaeology, art history, and restoration is increasing. From machine learning to field analysis, it offers a wide range of applications in conservation efforts and is also being used to raise public interest and awareness. Supporting advancements in conservation efforts for cultural transmission also raises both ethical and social issues.

The concept of memory must be considered in the transmission and preservation of cultural values. Freud, a neurologist who contributed to the understanding and definition of memory, argued that it is the practice of remembering and forgetting that emerges as a result of individual choices [1]. Bergson, who conducted studies contemporaneously with Freud, explained memory as images formed in the mind to represent reality after perception and argued that

perception consists of individual-specific imaginations that occur under cultural and psychological influences [2;1]. Cultural and psychological influences reveal that memory, in which society participates and interacts, is a social expression. Maurice Halbwachs, on the other hand, defines memory as the totality of images that a given community commits to collective memory as a result of social interactions [3]. Based on these definitions, It can be hypothesized that differences in cultural values can influence social interactions within a society in each generation, changing identity, and that the memory of the place where the interaction takes place can also be affected. This assumption can be supported by the words of Pierre Nora [4], who focused on the relationship between memory and place: when the connection between memory traces and place is severed, a disconnection from the identity of society in collective memory occurs.

It is important to convey cultural values through concrete and abstract expressions in space to ensure their retention and transmission in memory. Cultural value, or heritage, is defined by the International Council on Monuments and Sites [5] as any tangible or intangible entity that has survived from the past to the present, depicted as a reflection of constantly changing values, beliefs, knowledge, and traditions, without any ownership bonds. UNESCO categorized cultural heritage in 2003 [6]. Prominent among these classifications are tangible and intangible heritage. While UNESCO considers tangible heritage as physical structures, artifacts, and monuments, intangible heritage encompasses living expressions such as traditions, rituals, and oral narratives. Cultural heritage is the value that gives a society Its identity, distinguishes it from other societies, and preserves its identity by transmitting its cultural values across generations. These values are preserved in the memory of a society, ensuring their transmission to future generations. Thus, future generations embrace the values preserved in memory, strengthening their sense of belonging to the place they inhabit.

Cultural landscapes are among the spaces where cultural values exist. The concept of cultural landscape was first introduced by Carl O. Sauer in the 1920s, who argued that "culture modifies the natural landscape, transforming that area into a cultural landscape element" [7]. The first international convention to recognize and protect cultural landscapes was the World Heritage Convention in 1992. According to UNESCO's 2025 World Heritage Convention Operational Guidelines Report [8], "cultural landscapes" are defined as the joint creation of humans and nature and are considered cultural assets. Cultural landscapes are landscapes that demonstrate the evolution of human society and settlements over time, influenced by the physical factors of the natural environment and social, economic, and cultural factors. Various technological tools are preferred in the preservation, restoration, and documentation of these spaces. As a new technology that has emerged in recent years, the frequency of use of artificial intelligence tools in efforts to protect cultural values has increased.

When we look at the first definition of artificial intelligence in history, the concept was first formally used by McCarthy in the Dartmouth Summer Research Project Proposal report. McCarthy [9] defined artificial intelligence as software concerned with the methods used to access information sources in situations where accessing information is difficult. Subsequently, Newell [10] advocated for the development of "unified theories of cognition" that would encompass language, comprehension, motivation, imagination, and self-awareness—in short, the entire scope of human intelligence. Artificial intelligence can easily evaluate all logical, psychological, statistical, economic, individual, and collective perspectives incorporated into the software. Artificial intelligence does not experience the problem of one criterion over another. A conflict between criteria is a situation that only a human being can experience [11] AI, designed to be at human intelligence levels, lacks the ability to experience human-level emotions. This allows it to objectively analyze the data it possesses. Minsky argues that AI can evaluate everything from the simplest units with reasoning intelligence to the collective knowledge of more complex units [11].

Julien Schuh, who describes artificial intelligence as artificial memory, notes that technology giants are assertively positioning these productive AI models as primary intermediaries for accessing information [12]. It is inevitable that AI, which possesses all the characteristics of humans but, unlike humans, has the ability to utilize all of these characteristics simultaneously and at high performance, will become a technological assistant that will assist in research.

The aim of this study is to explore how elements of the cultural landscape of societies will change in their collective memory, where developing artificial intelligence technologies are linked. It aims to contribute to addressing the uncertainty surrounding the future impacts of these changes on the cultural landscape. In particular, the potential contributions of artificial intelligence to shaping cultural and historical urban fabrics are examined, along with examples. Recently, the number of studies on the relationship between artificial intelligence and cultural heritage has increased. The European Parliament is working to protect legal rights regarding the legal violations that this relationship causes and may cause.

The study conceptually addresses cultural landscapes, memory, and artificial intelligence, and provides examples of the use of artificial intelligence in cultural research, along with a classification of its applications. The general ethical and social issues that may arise from the use of artificial intelligence in cultural heritage projects are also discussed.

MATERIALS AND METHODS

This study employed a qualitative research method to understand the interaction between the concepts of cultural landscape, memory, and cultural heritage and artificial intelligence technologies. The study, which proceeded by conducting a systematic review of existing literature, utilized document analysis, a qualitative method, and analyzed academic articles, official reports, and projects during the data collection process. Both primary and secondary data sources were utilized.

The study aims to provide a general understanding of the impacts of artificial intelligence on cultural heritage and urban memory. However, the technical details of specific technologies are not explored, focusing instead on the overall impact of these technologies on cultural heritage studies. The number of examples examined in the study was limited, and a representative sample was used rather than an in-depth analysis. Finally, in the evaluation and conclusion section, traditional methods and AI-based approaches are compared, and their differences and similarities are assessed.

ARTIFICIAL INTELLIGENCE FOR MEMORY AND CULTURAL HERITAGE

Use of Artificial Intelligence in Cultural Heritage Studies

Today, the risky situation surrounding the visibility of cultural heritage assets within the cultural landscape is noteworthy. Increasing concerns in this area have motivated many researchers to take action and increased the number of conservation efforts. With the advancement of technology, utilizing technological tools has become a necessity in efforts to protect cultural values. Artificial intelligence, a constantly evolving tool, is a new technology facing humanity.

In conservation efforts, the digitization, analysis, and preservation of cultural heritage has become a preferred method. Artificial intelligence, which has become a popular technological tool, has also begun to be used in research examining the relationship between collective memory and cultural heritage. However, despite the benefits gained from its increasing use in conservation efforts, its inherent ability to programmatic reasoning has raised concerns for many researchers regarding the use of artificial intelligence. Consequently, the use of artificial

intelligence in conservation efforts has been examined, and the areas where it is used have been classified according to its role.

Artificial Intelligence in Documentation and Digitization Studies

Archiving and preserving the data obtained for the research and preservation of cultural heritage items is crucial. These archives not only constitute a valuable resource for preservation efforts but also serve as important memory reminders. In this context, the "documentation and digitization" process offered by artificial intelligence helps researchers by organizing a more comprehensive and systematic database, especially in situations where archives of cultural heritage artifacts are densely populated. Collecting information about cultural heritage artifacts can sometimes take longer than expected. Artificial intelligence accelerates this process, enabling the scanning and analysis of artifacts using image recognition technology [11, 12]. The Rebuilding Palmyra Virtually Project, where artificial intelligence is used in cultural heritage documentation and digitization efforts, and the mapping of cultural memory in Testaccio are discussed.

Rebuilding Palmyra Virtually

Palmyra is an ancient city located in Syria and listed as a cultural heritage site. The reconstruction of Palmyra is a significant project for the preservation and preservation of an ancient memory that bears traces of the past and is on the verge of being erased. With its magnificent temples, theater, and Corinthian columns, Palmyra is a unique place of memory for the world's cultural heritage. This heritage, now indistinguishable from rubble, was first created through documentation efforts, creating "ghost images." Satellite imagery and old photographs of the city were analyzed using artificial intelligence algorithms to analyze the physical structure. Using machine learning methods, most of the ruined structures were repaired and deficiencies were corrected, creating a three-dimensional model [13]. Thanks to the technological tools and methods used within the project, artificial intelligence has played a significant role in preserving cultural heritage. The cultural value preserved is critical for both world heritage and global memory. The memory element preserved by this project is the city itself. The physical recreation of the city's heritage has been holistically preserved through digital reconstruction. Denker himself stated that Palmyra must be preserved to prevent its erasure from the collective memory [13].

Mapping Cultural Memory in Testaccio

Testaccio is a district within the boundaries of a UNESCO World Heritage site in Rome. A study was conducted to document cultural values by collecting social media data from this region, which is home to a significant portion of cultural heritage and cultural landscapes. The study employed trained artificial intelligence algorithms for visual analysis, and linguistic analysis was used to identify cultural elements embedded in the public's memory. The pre-trained VGG-16 Imagenet artificial intelligence model used in the visual analysis was combined with Keras Python software. Data was collected and documented in a two-dimensional plane using coordinate logic using PCA and t-SEN. The data was then separated by user classifications such as local/tourist and English/Italian [14]. By separating the documented cultural values based on local and tourist-based sharing, the memory of the community that uses and lives in the place is documented (Figure 1).

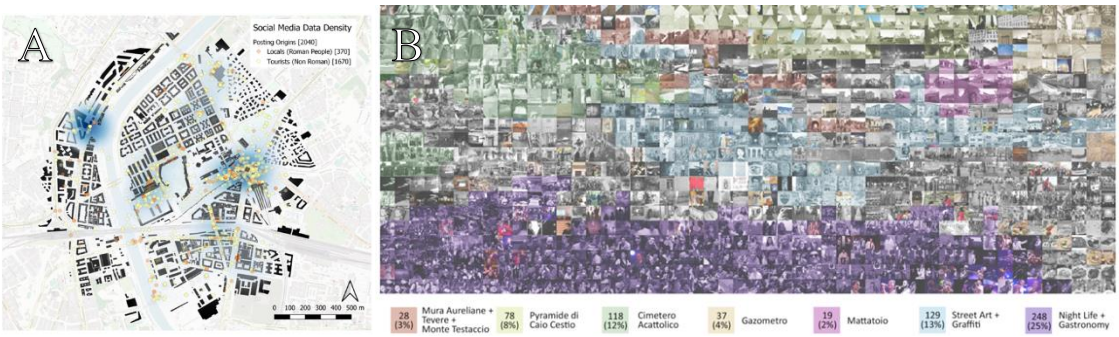


Fig. 1. *A: The map of social media images locations in the area of Testaccio [14]. B: Social media images based on the sampled content using t-SNE algorithm [14].*

Data on the reflections of this memory within the space, as seen through the eyes of tourists, is also collected, providing a basis for conservation policies. The translation of this region, which is on the World Cultural Heritage List, into a digital map constitutes a good example of the continuity of the Tiber River area, a cultural landscape, and other cultural elements in public spaces.

Both projects demonstrate the use of AI technology, combined with machine learning capabilities and visual and data analysis. The Palmyra project presents an ancient city, its culture, and structures, as a holistic experience through visual analysis. In the Testaccio project, city boundaries are removed and its surroundings are addressed within a regional context. In both projects, cultural heritage is entrusted to the user's experience and perception. Projects hosted in the virtual environment aim to protect, educate, and preserve cultural heritage by reaching a wide audience. In Testaccio, artificial intelligence was used as a mapping tool to identify cultural elements. Its purpose is to help identify and preserve local cultural elements in the region, ensuring their digital preservation to prevent the extinction of a culture. Similarly, a 3D model of Palmyra was produced to preserve a city and its culture, which is on the verge of extinction. By transferring cultural elements to the digital environment, spatial memory is revitalized and preserved. AI tools play the role of verbal and cultural carriers of memory in these projects. In the exemplary projects, artificial intelligence has served as a timeless digital memory while preserving existing legacies.

Artificial Intelligence in Restoration and Damage Assessment Studies

The use of artificial intelligence in cultural heritage conservation and restoration projects is primarily focused on preserving artifacts in their original state or restoring damaged artifacts to their original state. Damage analysis examines the physical structure of the cultural heritage, and the damage is appropriately classified through visual analysis. Classifying damage can provide crucial information about the urgency and status of the restoration work. By analyzing color, texture, and materials, it can make realistic predictions about missing or previously damaged areas. Beyond simply repairing damage and replacing missing parts, AI can also provide measures and recommendations to prevent future damage to the cultural heritage element.

Damage Assessment Project for Portugal's Tiled Cultural Heritage Buildings

The project aims to detect damage to the tiles on the exteriors of historic buildings, a part of Portugal's urban heritage, using a deep learning model, an artificial intelligence technology. Several different models were developed to identify damage types on the exterior tiles of historic buildings, known as Portugal's azulejos (Figure 2). Damage types were categorized as cracks, breaks, missing tiles, faded patterns, and no damage. The process of identifying and classifying damaged tiles was reduced thanks to AI technology, and the models achieved an

accuracy rate of around 95%. Smaller damages on the tiles were overlooked by the AI. The project leaders suggested that the AI model could be trained on photographs of both damaged and intact tiles to increase accuracy. While AI has significantly saved time in conservation efforts, it remains a technology with room for improvement. It has also contributed to conservation efforts by reducing maintenance costs for historic buildings [15]. Artificial intelligence has contributed to documenting conservation approaches that can be taken to protect these structures, which are an important part of the city's historical and cultural value, creating a useful resource for relevant institutions.



Fig. 2. *A: Tile ornamentation decorated cultural heritage buildings [15]. B: Damage typology detection results and percentages [15].*

Transformation and Heritage Planning of Fujian Houses

The round earth houses, also known as Fujian Toluo, are located in Fujian Province, China. Forty-six Tulou houses have been inscribed on UNESCO's World Heritage List. The YOLOv8 model was used to analyze and identify damage to these houses, which have stood for 800 years, and the cultural landscape in which they are located. The object detection method developed with this machine learning-based model was trained on images of cracks, holes, and damage. This method facilitated the conservation process by faster analysis of the historical site and saved time and money in renovation and restoration projects. While the model achieved an average accuracy of 57% in the final test phase, field trials yielded more effective results, with better than expected detection of damage such as cracks, stains, and holes. Using the AI model in developing a method that can be used in daily damage assessment has offered significant advantages in addressing the time constraints encountered in conservation efforts. This time savings has facilitated the transition of cultural assets to the restoration phase [16].

In both projects, artificial intelligence has made significant contributions to studies conducted to preserve, complete, or identify and repair artifacts true to their original state by leveraging extensive data archives. In the project conducted in Portugal, the AI model assisted in scanning cultural structures within urban spaces, while in China, damage assessment studies were conducted across the entire cultural landscape, where both historical structures and structures developed alongside the landscape. This use of AI in cultural artifacts and structures has strengthened their value in memory to a certain extent by completing missing elements in the collective memory. Incomplete artifacts may not be preserved in their original form over time. As perceptions change from generation to generation, heritage can also undergo changes, losing its originality and even its value in memory. For example, preserving tiles faithful to their original state in terms of urban memory will serve as memory traces for future societies to understand the artistic, architectural, and environmental perceptions of past societies. Furthermore, these memory traces are crucial for the community that will use that space to remember its identity.

Artificial Intelligence in Analysis and Data Interpretation Studies

Another application of AI in cultural studies is data analytics and data interpretation. Its application in this field has led to various applications, including inscription and language analysis, archaeological data analysis, large-scale excavations, the identification of lost architectural works, and the digital completion of missing artifacts by creating three-dimensional models [11].

Heritage Mission Project- Excavations in the Utrechtse Heuvelrug National Park

Human-induced destruction has been observed in the Utrechtse Heuvelrug National Park, a densely forested area in the Netherlands thought to contain prehistoric traces. Consequently, the development of a light-sensing, range-based LIDAR artificial intelligence program with a land-scanning plugin significantly benefits excavation efforts, preventing archaeological excavations from becoming more difficult and potentially damaging historical artifacts (Figure 3). LIDAR can scan without being affected by the presence of vegetation in the area, thus facilitating the investigation of archaeological remains in areas hidden by forests and other types of vegetation [17].

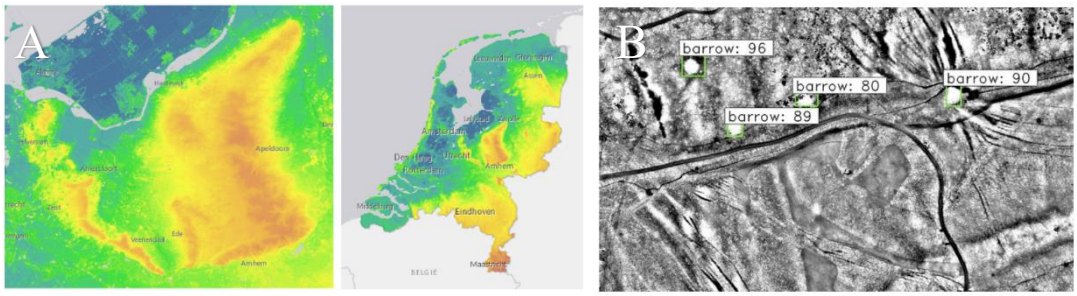


Fig. 3. *A: LİDAR elevation map of the Utrechtse Heuvelrug and the Veluwe in Netherlands [25]. B: Burial mounds, cart tracks and a part of Celtic field detected by machine learning [25].*

CyArk- Tikal Ancient City Project

The ancient city of Tikal, located in the Guatemala rainforest, was studied using digital documentation techniques in collaboration with UNESCO, CyArk, and the University of California. The research team completed a 3D model of this ancient Mayan city using laser scanning and digital photography, supported by artificial intelligence. The 3D model of the cultural heritage was transferred to a virtual environment by providing open access [18]. This allows people from around the world to explore and study the site online, ensuring that the cultural heritage of the Mayan Kingdom and the memory of the ancient city are preserved for future generations.

Lost Cities in the Amazon Rainforest

Archaeologists discovered an ancient city system in Ecuador's Upano Valley dating back approximately 3,000 years. However, due to the ancient city's complex system and its location within the rainforest, artificial intelligence technology was utilized in the research. They categorized the settlements using LIDAR technology as heat maps using land analyses [19]. Thanks to LIDAR, archaeologists discovered a city lost under the forest canopy, uncovering traces of a culture lost to time.

In all three project examples mentioned, the use of artificial intelligence facilitates the discovery and discovery of cultural landscapes. Studies that would have taken months or years

without AI technology can now be completed in a shorter time. In all of these projects, AI has made datasets, which were difficult to obtain and interpret, more understandable and accessible. This has enabled researchers to obtain highly accurate data in their efforts to understand and interpret cultures. In these studies, artificial intelligence has been used to uncover sites located on large scales and hidden beneath the natural landscape. It appears to have played a supporting role in these projects, primarily to support researchers' work. The contributions of advanced technology to data analysis and interpretation have prevented cultural traces from being lost across time and space.

Artificial Intelligence in Bringing Society and Cultural Values Together

Integrating memory producers with these values is crucial for maintaining cultural continuity. Artificial intelligence can serve as a crucial bridge in helping memory producers gain awareness, embrace their cultural values, and transmit them to the future.

THANADOS- Anthropological and Archaeological Database

THANADOS [20] identified the locations of Early Medieval cemeteries in present-day Austria, digitally collecting and providing open access to the information, datasets, and models they offer regarding their cultural significance. The data was mapped using CIDOC CRM, sponsored by ICOM, digitized, and made available online. The identified archaeological sites are displayed on an interactive map. Cartographic visualizations, graphics, and drawings were created based on actual archaeological research data. The cemeteries discussed here are cultural elements of medieval architecture dispersed throughout the cultural landscape and have survived the test of time. Cemeteries, which hold different values in each culture, provide information about the social and cultural values of the period in which they were built. They continue to live on as cultural reminders in the memory of the local community.

The Reconstruction Project of the Old Summer Palace (Yuanmingyuan)

The Old Summer Palace, known as Yuanmingyuan, located in China, is an important cultural and historical structure built during the Qing Dynasty in the 17th century. Unfortunately, by the 1860s, much of it had been destroyed. Thanks to digital technologies, the structure and its surroundings, which were at risk of extinction, have been recreated in a virtual environment, providing opportunities for cultural continuity, cultural tourism, accessibility, and educational use. To ensure the authenticity and accuracy of the heritage, a combination of live recordings from the field, historical documents, and 3D modeling methods were used. Data obtained from old plans, written, and visual historical archives were utilized in the remodeling of the heritage structure and its surroundings [21]. Machine learning methods were used to reconstruct the structures in locations and situations as close to their originals as possible [21] Once the 3D modeling was completed and a replica close to the original was created, virtual exhibitions were planned and made available to visitors via mobile devices (Figure 4). This gave visitors the opportunity to experience the restored palace visualized in real time [21]

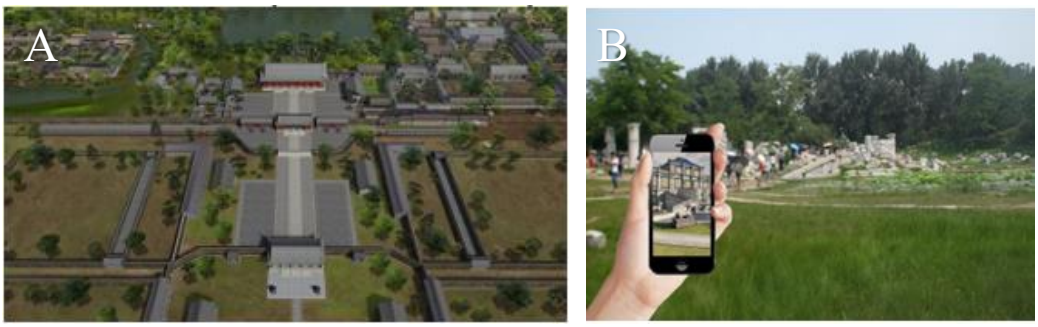


Fig. 4. A: 3D reconstructed model of Yuanmingyuan Place Gate [24]. B: Digital exhibitoin via mobile devices [24].

CONCLUSION

The concrete and implemented nature of selected exemplary projects worldwide is crucial for understanding the impact and contributions of artificial intelligence. In situations requiring fieldwork, such as the protection of immovable cultural heritage or protected areas, AI technology is highly preferred by researchers. The contribution of AI to urban memory lies in its ability to serve as a digital memory in the preservation of cultural heritage. The digitization of immovable heritage, particularly in heritage that is part of the urban fabric and culture, is particularly beneficial in completing the culture-space relationship within society and in maintaining the memory traces. As the connection between a cultural artifact and the place where the culture it is produced is strengthened, its place in society's memory will also be strengthened.

While artificial intelligence offers many beneficial uses, it has also raised ethical and legal risks. Because it is a new technology, a well-established legal framework does not yet exist globally. As its use grows, the legal framework of artificial intelligence needs to be further established. Organizations such as ICOM, IFLA, and UNESCO have begun developing their own ethical codes on this issue. One of the leading concerns is that the increased use of artificial intelligence and the digitization of cultural heritage may jeopardize the authenticity of the artifact. One of the conditions listed by UNESCO for defining cultural heritage is that a historical artifact must be unique in the universe, a condition that proves its authenticity. However, three-dimensional models created for digitization cannot be identical to the original [22]. The use of artificial intelligence in modeling cultural heritage originally created by humans can impart a non-human quality to the cultural heritage. This may prevent the artifact from conveying its originality and evocative feelings in the digital environment. This may prevent the observer from connecting with the artifact. Blocking the bond between culture and the individual may cause the heritage to be erased from the social memory [23].

Another disadvantage is the potential for misinterpretations arising from the uncontrolled use of resources utilized by AI. To ensure reliable responses, AI must be monitored and audited using methods such as impact assessment and verification. A fundamental ethical principle for the use of AI in the context of cultural heritage is the need to ensure reliability. Specifically, a professional or team in the field should be involved in audits to ensure AI becomes reliable. In studies using AI, the algorithm must interpret data fairly [17]. When interpreting a heritage asset, the algorithm references the interpretations of experts. While these individuals may be experts in their field and attempt to be objective, interpretation is inherently based on criticism. Therefore, the AI model must be developed under constant supervision.

Artificial intelligence technology should be used in conservation efforts without exposing the natural and cultural environment to technological pollution. Environmentally friendly technological tools should be chosen, taking into account the conditions of the land being studied. While AI technologies can accelerate research and enable effective analysis, they are expensive and may not always be a viable economic option.

People tend to forget most of the memories they have throughout their lives. Therefore, they want to preserve these memories and preserve these images by writing them down so they can recall them again one day. However, physical writing is insufficient to preserve these memories and elements of memory. Artificial intelligence technology offers various uses today for documenting, preserving, and digitizing memories for remembrance. Sometimes, technology helps us identify elements of memory that remind us of our cultural values and sociocultural identity through various methods. Preserving elements of urban memory and ensuring its continuity is often achieved through cultural elements and historical sites. Therefore, artificial intelligence technology used in cultural heritage studies will likely continue to provide significant benefits to urban memory in future studies, as long as the established ethical frameworks are taken into account.

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