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Artificial Intelligence and the Future of Cultural Preservation: Safeguarding Cultural Heritage in the Digital Age

ONI, Timothy Olamide

Department of Christian Religious Studies Caleb University, Imota, Lagos State

MAKINDE, Oluwasegun Faith

Department of Christian Religious Studies Caleb University, Imota, Lagos State

AKINYERA, Abideen Tope

Directorate of General Studies Abraham Adesanya Polytechnic, Ijebu-Igbo

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ABSTRACT: The emergence of artificial intelligence (AI) technologies has opened new horizons for innovative and efficient protection methods in this field. This study examines artificial intelligence and the future of cultural preservation: safeguarding cultural heritage in the digital age. Artificial intelligence technologies are revolutionizing the digitization and documentation of cultural heritage assets. Automated scanning, 3D modeling, and virtual reality applications facilitate the creation of accurate digital copies, increasing accessibility for researchers, educators, and the public. In the field of conservation, artificial intelligence algorithms play a crucial role in identifying damage and formulating targeted restoration plans for deteriorated artifacts and structures. Using AI, the scene of intangible cultural heritage is restored from multiple dimensions and perspectives, so that users can have a more intuitive and in-depth understanding of the cultural deposits and historical connotations behind the intangible cultural heritage preservation when they contact it.

KEYWORDS: Artificial intelligence, cultural heritage, preservation

INTRODUCTION

Nigeria is a country located in the Eastern part of West Africa. Geographically, Nigeria occupies a space of 923, 768 sq. km, and is the most populated (over 140 million, based on the 2006 census figures), multi-ethnic and multilingual country in Africa, with over 250 ethnic groups. It has the Igbo on the East, the Yoruba on the West and the Hausa-Fulani to the North as major ethnic groups among others perceived “minor” ethnic groups. Nigeria is a nation bestowed with a lot of cultural heritage derived from its multicultural communities. In other words, heritages are significant endowments arising from man and nature. Nigeria is a colourful combination of culture and landscape, a place that fully embraces its African cultural heritage and celebrates its diversity.

Culture is a quintessential characteristic of human beings. It is human beings who create culture; non-human animals don't create a culture. Culture is an essential of society. Every society or community has a culture. It is indeed true that all of society is culture. Yet culture can still be singled out as the subject of discussion. Cultural heritage is vital to the functionality of the Nigerian society. Without cultural heritages being preserved in Nigeria there will be no Nigerian society. It is through preservation of cultural heritages that the values, norms, mores, laws of the Nigerian society are passed on from generation to generation. Cultural heritage has a role to play for the wellbeing and welfare of the society. Without cultural heritage the Nigerian society will be dysfunctional and disordered.

Cultural heritage binds a society together, gives a sense of collective belonging, affinity, solidarity, and communal identity. Cultural heritage is a term that contains both tangible and intangible values. Most of the cultural elements are part of the heritage and can be called cultural memory. As a crucial component of identity, the heritage (cultural memory) of previous generations must be passed on to current and future generations (e.g., via historic sites) (Nocca, 2017). Many conservation practices have been developed to pass on this cultural heritage preservation to future generations, but the most recent are those with artificial intelligence (AI). AI and new Technologies became critical solutions for protection and conservation because it helps to solve previous difficulties (Chaillou, 2020).

Artificial intelligence has largely become an integral part of our lives. It no longer represents science fiction, but a reality with applications in all spheres of modern life, from a virtual personal assistant that helps us organize our working day, through traffic control, to autonomous vehicles whose use is a reality today, through inevitable use in medicine, education, agriculture. up to the application of mobile “smart” phones, without which we can hardly imagine the life of a modern man (Stojanović & Ševo, 2023). In today's rapidly evolving digital age, artificial intelligence (AI) has emerged as a transformative force across various sectors.

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From healthcare to finance, AI's ability to process vast amounts of data and automate complex tasks has made it an indispensable tool. Xanthaki (2011) says notwithstanding the significance of individuals in discourse on rights, collective rights such as cultural rights that gives the individual meaning should not be denied. This study focus on preserving culture through AI digitization of recorded oral culture. Greed, religious beliefs, ignorance, conflicts and neglects have also contributed to degradation of cultural heritage. All these have negative effects for civilization as cultural values and norms are lost in the process. It is therefore imperative to empirically study artificial intelligence and the future of cultural preservation: safeguarding cultural heritage in the digital age

Framework of Cultural Heritage Preservation

Culture can generally be defined as the totality of a people's way of life inclusive of their arts, sciences, technologies, religions, agriculture, food, and diverse ways of interacting with their environments. Society is the object and subject of analysis in these functionalist perspectives. All the individual parts function in an inter-related and cooperative manner to enhance the good of the whole body. Whatever human creates in the process of their interactions with their environment becomes their cultural heritage. While some cultural heritages both tangible and non-tangible ones are more valuable than others, some are of lesser significance. For continuity of the human race and transmission of values from generation to generation, humans need to preserve their cultural heritages. If this is not done the basis for continuity of the human community will be lacking. People have a right to the enjoyment of the benefits of their cultures and to the preservation of that culture.

Cultural heritage is the legacy of physical artifacts and intangible attributes of a group or society that are inherited from past generations, maintained in the present and bestowed for the benefit of future generations. According to Franchi (2019) cultural heritage is a people's shared communal bond representing their history, identity, past, present and indicative of the future passed on from generation to generation. Cultural heritage plays a fundamental role in the identity and continuity of societies. It encompasses both tangible and intangible elements, ranging from historical artifacts, monuments, and architecture to rituals, oral traditions, music, and indigenous knowledge systems. For African communities, cultural heritage is not merely an expression of the past but an active, living tradition that connects people to their history, spirituality, and environment. It fosters communal bonds and serves as a moral and ethical compass for societal interactions.

Cultural heritages evolves from man's activities, preserved and transmitted through oral traditions or in written concrete forms a cross generations of human societies. Oral tradition is the body of information concerning history, culture and environment of a people at any given time and space, usually obtained through the words of mouth. Cultural heritage preservation refers to all the actions, activities and processes that are carried out to prolong and keep from degradation of cultural heritages. Cultural membership and the preservation of one's culture is both an individual and a group right. With regard to the question of group right, Kusumalayam (2008) notes that the idea of collective or group rights may have its origin in the rights of States (to territory, political independence, sovereignty, etc).

Today various international human rights instruments have come to acknowledge that aside States, minorities, indigenous peoples, and other groups have rights. One of the core rights that groups have is the right to their culture and the preservation of that culture. Throughout history, cultural objects have attracted the attention of mankind for numerous reasons: In war time, they have been looted as trophies to pay troops, or to further humiliate the enemy. In time of peace, group have been both subject of clandestine excavations and served as gifts to foreign dignitaries and were objects of trade. In recent times, also, they have become objects of scientific interest. While some of these activities have long been illegal, such as clandestine excavations, others have been illegal with the passing of time such as looting of an enemy's cultural treasure. Some continued to be legal, for instance, the legal trade in cultural property, whereas, others even though considered legal in a strict sense, raise moral issues, such as transfer of artefacts from colonies to the colonial powers in the former times (Tasdelen, 2016).

Framework of Artificial Intelligence

Artificial intelligence technology (AI), refers to the intellectual behaviors made by humans, including perception, reasoning, learning, communication, and behavior in complex environments, which aims to create machines that can perform these behaviors as well as or better than humans in the long term. Artificial intelligence is essentially a comprehensive use of computer technology, simulation technology, image technology, language technology, network technology, multimedia technology, data technology, virtual reality technology to help the simulation of human intelligence activities, so as to effectively integrate science, philosophy, art and other disciplines. The emergence and development of artificial intelligence is a long process. As early as hundreds of years ago, people began to imagine smart tools. Many countries, including China, can find visions and descriptions of smart tools in their literary works. The development of modern artificial intelligence technology provides some ideas and inspiration. Artificial intelligence has undergone changes in mechanical automation, electronic automation, and information automation. Simultaneously, artificial intelligence is also beginning to play an important role in the current protection and dissemination of cultural heritage. In recent years, combined with big data, 5G network environment and 8K display technology, digital cultural heritage relies on artificial intelligence to transform, reproduce and restore cultural heritage into shareable and renewable digital form, comprehensively enabling and effectively transforming cultural heritage into productive forces. However, compared with material cultural heritage, the application of intangible cultural heritage in artificial intelligence technology is still relatively weak. General Secretary Xi Jinping specifically pointed out: "We must be good at organically unifying the promotion of excellent traditional culture and the development of real culture." How to organically combine science and technology with excellent traditional culture and develop in inheritance is a key research field. During the two sessions in 2019, General Secretary Li Keqiang included artificial intelligence in the government work report for the third time, putting forward the important concept of "intelligence plus" for the first time, and it was highlighted in a separate paragraph, demonstrating the determination and confidence to promote the AI strategy at the national level. The organic combination of "intelligence + intangible cultural heritage" will make the intangible cultural heritage and its unique charm better spread.

Forms of Artificial Intelligence for Cultural Heritage Preservation

There are a number of artificial intelligence tools that can be used to promote cultural preservation heritage. These tools enable better research, interpretation and access to cultural artifacts and information. Here are some examples (Stojanović & Ševo, 2023).

Digitization and Archiving: High-resolution scanners and 3D scanners are used to create digital copies of works of art, monuments and other cultural artifacts. Artificial intelligence can analyze these digital copies to detect corruption and enable detailed analysis.

1. Text Analysis: Natural Language Processing (NLP) tools are used to analyze text documents such as manuscripts, books, diaries and inscriptions. These tools help in automatic translation and transcription of text, making it easier to access information in different languages.
2. Computer Vision: Computer vision techniques are used to analyze images and videos of cultural artifacts. Recognizing patterns, styles and details facilitates the analysis and interpretation of works of art.
3. Virtual Reality (VR) and Augmented Reality (AR): VR and AR technologies allow visitors to explore virtual reconstructions of historical sites, museums and monuments. Visitors can have interactive experiences and a better understanding of cultural artifacts.
4. Generative Models: Generative models, such as GANs (Generative Adversarial Networks), can create new works of art inspired by the styles of old masters or characteristics of certain periods.

Effect of Artificial Intelligence on Cultural Heritage Preservation

Culture is regarded as the lifestyle of the people and it is expedient that, the culture could be defined based on place and time due to the advancement in the people and the time at which various incidences occur. The sustainability of culture therefore becomes essential for a people owing to the fact that, humans are defined by time and fading away is inevitable therefore, this section examines the need for Artificial Intelligence in the sustainability of culture of people. Since AI is being included into the systems that safeguard cultural legacy more and more, its effects on cultural preservation are becoming increasingly significant.

Leading the way in this integration is the United Nations Educational, Scientific, and Cultural Organisation (UNESCO), which promotes ethical AI as a critical component in preserving varied cultures and legacies across the globe (Gondola, 2024). This implies that, it is internationally realised that AI provides great and significant advantage to the sustainability of people's culture with the attestation of UNESCO. In the realm of cultural heritage, AI holds significant potential to enhance the documentation, preservation, and dissemination of cultural artifacts and traditions. Ma (2018) identify AI technologies, such as machine learning algorithms, virtual reality simulations, and automated data analysis, can help manage African cultural heritage in ways previously unattainable. This potential is particularly pertinent for the African continent, where cultural artifacts and indigenous knowledge systems are at risk of erosion due to factors such as globalization, modernization, and environmental degradation. The relationship between cultural heritage preservation and economic growth is becoming increasingly evident in Africa.

EMPIRICAL REVIEW

Khabzaoui and Cherifi (2025) examines the pivotal role of artificial intelligence (AI) in preserving cultural heritage. This underscores AI's applications in digital documentation, artefact restoration, visitor engagement, and cultural data management. This study highlights how AI technologies, including 3D scanning, machine learning, and predictive modelling, have enhanced conservation efforts. Additionally, it examines the potential of AI in preserving intangible cultural heritage and creating global repositories of cultural information. The text concludes by addressing the ethical considerations associated with the use of AI in cultural heritage conservation. It emphasises its increasing significance in safeguarding the cultural legacy for future generation.

Bolarinwa (2025) examine artificial intelligence (AI) and cultural heritage: an integration of ai in the sustainability of cultural orientation Artificial Intelligence (AI) is one of the most advanced form of technology and this is peculiarly seen to have come to play in the 21st century. It is without doubt that one can asseverate that AI has gone a long way to communicate the advancement of human capabilities at utilizing various means to provide a conducive and convenient society. In the face of this advanced form of technology, the riddle provided is the implication on culture especially African culture. The influence of AI cannot be overemphasized across various spheres and this could be perceived in the light of progression of culture of the people as its influence cannot be neglected or ignored. In advancing this thought, this paper using the evaluation methods examines the contribution of AI to cultural progression with a focus at the sustainability of the African Cultural orientation. The work resolves that, AI could be maximized as a means of sustaining the culture of the people rather than being a bane to the sustainability of the people's culture. As such, the use of AI is largely encouraged across the culture of the people in preserving their cultural heritage which can undoubtedly outlast the current generation of practitioners of such culture.

The widespread adoption of generative artificial intelligence (GAI) technologies heralds an era of expanding possibilities in the domain of cultural heritage conservation. This paradigm shift is marked by a confluence of innovative methodologies, including digital twin mapping, digital archiving, and enhanced preservation strategies, aimed at safeguarding the vestiges of our shared past. The application of AI within this field represents a frontier where technology and tradition intersect, offering new vistas for the preservation of historical structures and artifacts that are at risk of deterioration or oblivion. This article endeavors to elucidate the perspectives of professionals within the conservation domain on the integration of AI technologies, drawing upon a comprehensive review of scholarly discourse and the insights derived from a qualitative study. These discussions brought forth rich insights from a spectrum of professionals, each contributing unique perspectives based on their domain expertise and experiences. Participants included conservationists, archaeologists, museum curators, technologists, architects, and restorers, among others, whose collective wisdom paints a multifaceted picture of the challenges and opportunities AI presents in this field.

Der-Lor and Yu-Hsien (2023) examine 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

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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, Caroti, Piemonte, De Luca, and Véron (2023) investigate 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.

Artificial Intelligence and the Future of Cultural Preservation: Safeguarding Cultural Heritage in the Digital Age

Many of the printed texts and manuscripts we possess today, already greatly eroded by the ravages of time, may be lost forever within the next few generations. The solution is their digitization, which will enable easier storage and protection for a much longer period of time. Digitized data is more easily accessible to researchers, and the data obtained by digitizing a huge number of documents can be used to improve artificial intelligence methods and create functional models. According to (Neudecker, 2022), artificial intelligence and machine learning have enormous potential in (semi)automatic selection, organization and preservation of cultural heritage in libraries, archives and museums, as well as in computer analysis of cultural heritage data. Some of the capabilities provided by artificial intelligence used in digital libraries are text recognition from historical written documents, even writing techniques. The application of artificial intelligence (AI) in cultural heritage is an area that brings numerous innovations and opportunities.

With the help of artificial intelligence and big data analysis, the dissemination and transformation of intangible cultural heritage can be realized in a larger scope, and the value of digitization of intangible cultural heritage can be enhanced and broadened, so that more people have the opportunity to have an in-depth understanding of the intangible cultural heritage (Zuo, 2007). For example, with the help of AI and virtual reality technology, the scene of intangible cultural heritage is restored from multiple dimensions and perspectives, so that users can have a more intuitive and in-depth understanding of the cultural deposits and historical connotations behind the intangible cultural heritage when they contact it. It is time to integrate AI technology into the transmission process of intangible cultural heritage, better disseminate the intangible cultural heritage through scientific and technological means, and realize the digitization, information, networking and intelligence of the transmission of intangible cultural heritage. At the same time, the continuous development of neural network and deep learning AI technology provides more application scenarios for intangible cultural heritage.

Natural language, image recognition, intelligent interaction and other technologies in AI can present the contents of intangible cultural heritage in an all-round and three-dimensional way, improve people's visiting experience, attract more people's attention, and thus create a new pattern of "coming alive" in the protection and inheritance of intangible cultural heritage. The interactive characteristics of the Internet can deepen the interactive experience between users and the intangible cultural heritage platform, making users' receiving of intangible cultural heritage information turn from passive to active, so that they can explore and innovate more possibly. Internet technology can give full play to the advantages of diversity of intangible cultural heritage, strengthen the connection between people and intangible cultural heritage, make it into people's vision, into people's life, so as to provide a broader space for innovation and development of intangible cultural heritage

Machine learning is the most advanced area of artificial intelligence. It refers to the designing, training, and deploying of models to applications, processes, and other machines by providing algorithms. Application Programming Interfaces (APIs), development and training toolkits, data, and computing power (Chen, 2019). Goksel and Bozkurt (2019) added that Machine learning is a system in which existing data is used for future predictions. Machine learning integrated into natural language processing to provide text-to-speech applications, language-to-language translation applications. For example, Google Translate created from a set of machine learning algorithms rely on Natural language processing to recognize speech and synthesis, allowing students to understand or pronounce words they have never encountered before (Kucak et al., 2018). Machine learning has changed the way information is search for by automating related suggestions to users and making recommendations for information to search with just a click.

Deep learning also known as deep neural network is a technology for implementing machine learning. Deep learning is primarily used in pattern recognition and classification applications supported by large data sets (Chen, 2019). Deep learning allows virtual assistants to detect and understand speech, images, sound and videos. Deep learning has increase the efficiency of online learning as adapted cultural software are used in online environment which makes it easy to meet individual needs othus fostering personalised learning and offer an opportunity for pople to get extra assistance from tutors.

By harnessing AI technology, heritage professionals can enhance their skills and contribute to sustainable conservation efforts. AI offers cost-effective and efficient restoration approaches, ensuring the preservation of World Heritage Sites and cultural diversity for future generations. As AI continues to permeate various aspects of Human lives, it is imperative to steer its cultural impact towards a future that embraces diversity, inclusivity, and ethical responsibility. By utilising the transformative power of AI with foresight and intentionality, we can shape a future where technology and culture align to elevate humanity and enrich our shared experience. Looking ahead, we envision a future where AI fosters a more inclusive and culturally vibrant society, where creativity flourishes, diverse perspectives are celebrated, and ethical principles guide technological innovation.

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CONCLUSION

Cultural heritage constitute an inalienable past of a people's sense of self and of community, functioning as a link between the past, the present and the future. It is necessary to sensitize the public about their cultural heritage and especially the younger generation. Unique and exceptional artworks, and movements, ritual objects, national symbols, ancestral remains, dismembered pieces of outstanding works of arts are irrevocably identified by reference to the cultural context in which they were created . There is need to preserve and conserve the cultural heritages of the people for posterity, for it is their original context that gives them their authenticity and unique value.

In the context of the great integration of art and science, the innovative design of artificial intelligence and intangible cultural heritage continues to experience pioneering innovation. It is time to record, protect, inherit and apply the intangible cultural heritage projects that are still alive today through artificial intelligence technology, so as to preserve the precious intangible cultural memory for mankind in the future, which has immeasurable historical value and humanistic value. It is expected that artificial intelligence technology can be effectively applied to the protection and inheritance of intangible cultural heritage, give play to the creativity of artificial intelligence, promote the sharing of intangible cultural heritage resources, effectively expand the scope and speed up the transmission of intangible cultural heritage, and open up new ideas for the inheritance of intangible cultural heritage. AI technology integration with cultural heritage conservation marks a revolutionary change in the approaches used to protect cultural treasures. The role is inestimable if properly approached by the users. Technology, policymakers, cultural practitioners, and society at large must work together to navigate the complexities of AI and make sure that it is a tool for positive societal transformation.

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