

## Preserving Ephemeral Traditions: A Chain of Custody and Semantic Storage Framework for Motion-Captured Intangible Cultural Heritage

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### Abstract

While the use of motion capture technology helps safeguard ephemeral intangible cultural heritage (ICH), issues arise with the integrity, authenticity, and enduring usability of digitised assets. This paper presents an expansion of the existing motion capture preservation framework which consists of pre-production, production, and post-production phases by adding a robust chain of custody based on respect des fonds. This custodial principle of respecting context, origin, and ownership is modified to document the capture, editing, storing, and disseminating lineage of ICH data. By placing metadata documenting each custodial shift alongside contextual data within cultural ecosystems, the proposed chain of custody provides referential legitimacy and traceability to the seized motion artefacts wherein such artefacts are secondary to primary reference artefacts. Moreover, these artefacts under the proposed framework would fall under a semantic preservation storage system that uses ontologies and linked data models depicting relations between elements of ICH, ICH creators, and their socio-cultural relevance, thus enhancing but not degrading data reliability. This proposed framework enables cross-disciplinary frameworks without loss of contextual accuracy and mitigates data downgrading while enhancing contextual relevance. Such an integrated approach addresses motion-captured ICH throughout its life cycle, ensuring the accuracy and integrity of digital heritage preservation while being unchanging and semantically valid for scholarly, educational, or creative use. In developing methods to preserve the authenticity and control of intangible heritage within a global memory framework that is becoming digitised, this work integrates digital preservation technologies with archival science.

**Keywords:** *Digital Preservation, Chain of Custody, Authenticity.*

### Introduction

Intangible Cultural Heritage (ICH) refers to the practices, traditions, knowledge, and skills of the people that are passed down through generations. These heritages emerge in various forms, including oral traditions, performing arts, games, social rituals, seasonal celebrations, nature worship, and technical craftsmanship. It serves as a means of identity and promotes sustainable development among communities, groups, and individuals (UNESCO, 2003). However, ICH is by nature fragile and constantly evolving. It sustains numerous threats due to globalisation, socio-economic shifts, and environmental changes that need effective preservation methods.

The enactment and transmission of Intangible Cultural Heritage (ICH) are its only modes of existence, in contrast to tangible cultural heritage which benefits from physical acts of preservation. Complications surrounding authenticity, data integrity, and long-term usability are raised when ICH is encoded using motion capture technologies. When placed within the context of processes involving motion capture, existing digitised preservation techniques... are often overlaid with the more pronounced general, rather than ICH specific, considerations. These approaches—the primary concern with capturing or providing access to the data—act to transform the data into resources devoid of context, provenance, or the cultural significance that enables interpretation and understanding, which greatly diminishes the interpretative value. Absent context diminishes the value of the record to enable critical cultural scholarship contextualisation, where the culture and its expression can be meaningfully appreciated as culture, through the performance, in future generations.

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There is therefore a pressing gap in the literature for improved systems of archival science that simultaneously address the challenges of accurate provenance capture and annotative enrichment. The preservation of motion-captured ICH refers to an expanding frontier that increasingly pushes the boundaries of traditional archival frameworks. This paper seeks to meet these gaps by suggesting integrated design combining a chain of custody anchored in archival respect des fonds and semantic preservation storage approach. The aim is to provide for enduring custodial accuracy and transfers, enriched contextual metadata for scholarship, education, and creative endeavour on ICH captured through motion technologies.

## **Literature Review**

### **Intangible Cultural Heritage (ICH)**

The UNESCO Convention for the Safeguarding of Intangible Cultural Heritage in 2003 marked acknowledgment of Intangible Cultural Heritage (ICH) on an international scale. ICH is defined as “practices, representations, expressions, knowledge, skills - as well as the instruments, objects, artefacts and cultural spaces associated therewith” (UNESCO, 2003, Article 2). In contrast to relics and monuments of tangible heritage which includes physical artefacts and places, ICH exists within the performances, practices and traditions of a community which are enacted and transmitted through generations. Its characteristics include ephemeral manifestation in the form of dances, songs and rituals, community-based origins where it gets its meaning and value from being rooted in a particular society, context and locale, adaptability to gradual changes in the environment, history and society, and reliance on oral transmission, apprenticeship and informal learning rather than formal education. ICH facilitates community cohesion and identity reinforcement for the enhancement of cultural diversity as well as sustainable development through culture-based tourism and traditional livelihoods. However, the non-material and intangible preservation present intricate difficulties, as fluid boundaries do not allow for control or documentation readily available through written form, photographs, or sound recordings.

Other threats such as uncontrolled international integration that may erase local cultures; social changes that disturb traditional structures; lack of recognition or support by governing bodies; and environmental deterioration also threaten ICH continuity. Preserving ICH requires immediate action that goes beyond attempts at integrating ‘one size fits all’ frameworks into adaptive approaches that genuinely appreciate the diversity and fluidity of cultural expressions.

### **Motion Capture Technology for ICH**

Whether recording or conserving Intangible Cultural Heritage, capturing an object's motion is one of the greatest technologies available due to its sophisticated structure. This is because it addresses the inadequacies of traditional documentation systems. Capturing an object's motion is based on tracking and recording movements of a subject using specialised sensors or markers in a 3D space. Such data can be analysed, manipulated, and the computer-rendered data can be visualised. Employing computer animation to digitally reproduce movement images, unlike other methods, preserves ICH without losing any body language details, gestures, and postures. Motion capture preserves heritage with little to no bias as the recorded motions tend to be as close to the actual performance as possible. In addition, motion capture enhances replicability because the reenactment data can be stored digitally and used in the future for educational purposes. Motion capture eases data dissemination through the Internet, thus improving public access. Various forms of ICH such as traditional dances, musical performances, craftsmanship, and indigenous games can thus be documented in rich detail using motion capturing.

Even with these benefits, the use of motion capture technology in preserving the intangible cultural heritage (ICH) has some shortcomings. As with much technology, access to motion capture equipment and software comes with a price, along with the required technical skills. These constraints pose barriers for many cultural institutions and communities, especially those lacking financial resources. In addition, the advanced data storage systems needed to manage motion captured data add to the expense. While motion data selection objectively captures moving processes, it often lacks contextual meaning which assists in interpretation. Without rich contextual metadata, results can be produced that lack adequate representation of how culture is practised. Moreover, the primary challenges of restrictions associated with data ownership, accessibility, and control, particularly for sensitive and private cultural representations raise substantial ethical dilemmas. Thus, it is evident that, although

motion capture provides powerful capabilities for documenting ICH, its proficient use necessitates the context of ethics, caretaking of data, and contextualised methodologies.

### **Digital Heritage Preservation**

The preservation of digital heritage refers to the processes and plans developed with the goal of providing ongoing access to culture, history, and science in a digitised format. In the context of Intangible Cultural Heritage (ICH), this refers to the safeguarding of the cultural products created with technologies such as motion capture. Crucial aspects of digital heritage preservation involve authenticity, which is the preservation of a digitised object's identity, essence, and precision relative to the original version without alteration; integrity, protection of the content from destruction, removal, or change; provenance, the custodian and history of the digital asset; reliability, verification the content renders accurate representation of actual events or deeds; and usability, the extent to which the users, past and present, are able to access and interpret the digital object.

Maintaining effective digital preservation also requires consideration for the long-term preservation of digital assets in relation to software, hardware, or technical platform changes. These needs are addressed by many preservation strategies. Using controlled structured metadata is fundamental to describing and managing digital objects as it contains valuable information such as item type, format, date of creation, and history of the item. Carefully choosing file formats which are documented, stable, and reliable contributes to the longevity of the files. Implementing adequate storage and backup redundancy to safeguard against data loss or deterioration is required as well. Migration approaches concern the transfer of digital content to new storage media or changing them to newer formats with the advancement of technology, while emulation focuses on reproducing the original software and hardware needed to operate digital assets. It is also important to note that planning policies, strategies, procedures, and long-term governmental oversight are necessary for preserving the digital heritage collections in a way that ensures ease of access, authenticity, and value over time. For these reasons, ICH which has been motion captured, can be captured with culturally significant context for future generations as it relies on such preservation policies.

### **A Respect des Fonds-Informed Chain of Custody**

#### **Adapting Respect des Fonds**

The application of *respect des fonds* serves as a guiding principle in the archiving activities of Intangible Cultural Heritage (ICH) preserved using motion capture technologies, highlighting the importance of protecting contextual authenticity throughout the entire lifecycle of its records. With respect to motion capture, this principle requires comprehensive recording of all activities constituting data creation, storage, and retrieval, as well as drawing data. This methodology preserves the performance of ICH itself as the \*fonds\*, the unit of meaning and value with archival significance. Motion capture data as well as all associated metadata should be catalogued within a context which is direct in relation to this epicentre source constituency, where context is the original performance.

To maintain this principle, a holistic account of the performance creation context which needs to be ethnographic such as the community or the individuals doing ICH, and other culturally relevant issues must be gathered as well. Such aspects are fundamental for data recorded in this manner to be interpretable. Moreover, it is required that all changes to motion capture data, edits, structuring, or annotation must be documented in detail to ensure authenticity, and an unaltered version of the recorded data can be traced.

The structural custodianship a motion-captured ICH object undergoes for its handover, dealing, handling, storing, and managing ICH data into and out of various hands, systems and/or institutions. This sequence of responsibility is a means of accountability, and a means of data integrity guarding from vandalism. All these factors combine to ensure that the motion-captured ICH is dealt with in a responsible way that does not damage the cultural significance and evidentiary and archival value of the data over time.

#### **Phases of the Chain of Custody**

The workflow for preserving the motion-captured Intangible Cultural Heritage (ICH) is built within the bounds of a custodian chain that covers four distinct steps which combine to create a cycle for a digital asset.

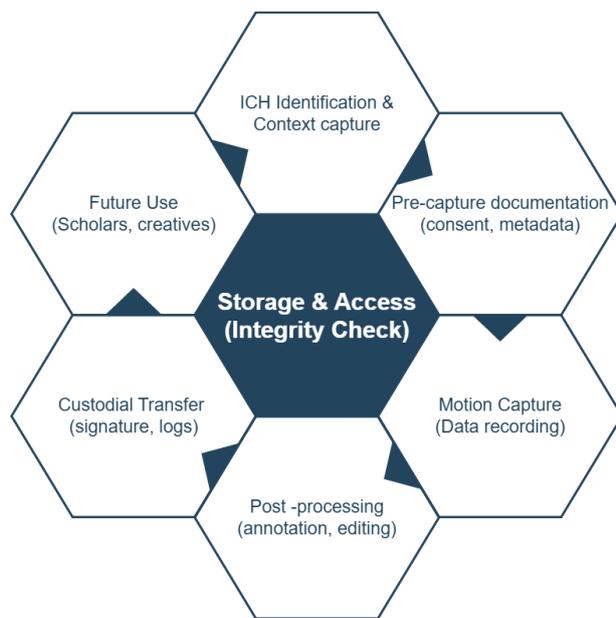
**Pre-production Phase:** This step involves defining the boundaries of motions to be captured together with the wider cultural setting of the ICH performance. In this phase, the cultural context of the

practice, identity of the performer, alongside the social and cultural milieu where the heritage expression is situated is mapped out. These are all the ethnographic contexts which inform the ICH which requires data to be captured.

**Production Phase:** In this phase, the actual motion capture is executed. Capture all the physical movements using motion capturing equipment. Also, there needs to be extensive capturing of the environmental state as well as the conditions of the equipment used, and the roles of the people in attendance. Data capture is done with utmost fidelity to ensure and control detail for both the technical and cultural factors during the recording session.

**Post-production Phase:** The collection of motion data initiates a progression that involves processing and refinement stages. Editing, annotating, and attributing the data with relevant decorations are included in this stage. Careful consideration is given to the preservation attempts made on the raw data concerning edits made as metadata enhancements to track the history of the data. Steps taken to modify the data must be well logged so that verification of the preserved information's continuity integrity is possible.

**Preservation and Access Phase:** Motion data in this final phase, processed and semantically enriched, undergoes placement in a protected digital repository. The primary task during this phase is defining policies for retention and access; controlling user access level; and restricting the data's usable authenticity scope for long retention duration strategies. To ensure ongoing usability, authenticity, and integrity of the information, strict security measures as well as routine audits mitigate the risks of information alteration or unauthorized access.



**Fig. 1.** As the lifecycle of Intangible Cultural Heritage (ICH) motion capture technology suggests, there are custodial phases of capture from identification to planned future reuse.

**Storage and Dissemination Phase**

The storage and dissemination stage is one of the most critical phases in the process of recording Intangible Cultural Heritage (ICH) movements, as it involves essential data management activities. These include proper organisation, effective storage, and systematic retrieval of the data collected throughout the project. At this stage, heritage assets are structured not only for practical preservation but also to ensure their integrity and long-term usability. The first step involves documenting all procedures and policies related to the storage media. This may include details about the type, format, and condition of the storage media, as well as protocols for editing, transferring, or organising the data. It's also important to establish policies concerning storage locations—both digital and physical—to ensure that the data remains accessible and properly managed. From a data interaction standpoint, it is crucial to define and communicate appropriate cultural and ethical boundaries regarding access to the information. These boundaries should reflect cultural sensitivity, ethical responsibility, and sound data governance principles. A clear framework is needed to determine how and when institutions or the

public can access the data, along with the tools, platforms, or mechanisms used to control, distribute, and monitor its usage.

A comprehensive strategy is essential for long-term data management. This includes procedures for data migration, handling data redundancy, and addressing technological changes over time. To preserve the accuracy and integrity of the recorded movements, regular integrity audits are vital. These audits may use checksums or other methods to detect any unauthorised alterations or data corruption. Collectively, these measures help ensure that the motion-captured ICH remains authentic and reliable for future scholarly, educational, or cultural heritage-related use.

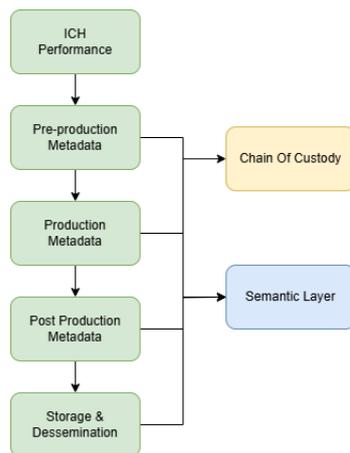
### **Integrating the Chain of Custody and Semantic Storage**

The dual approach for the conservation and motion capturing of Intangible Cultural Heritage relies on the synergy of the chain of custody approach and b. the semantic storage preservation model. It relies on a holistic context where preserved heritage, genealogy, and perpetual data immunity resides. The system maintains both data integrity and structural compliance, verifying that heritage is preserved within a bounded system of interpretive frameworks and profound cultural significance. It is not merely technical recordings.

Also, the integration improves both assurance and dependability; increasing trust for data mitigated by custodial caretaking and semantic context enhances dependability and trust. This is essential from a scholarly perspective as well as under legal and cultural heritage contexts where data authenticity and reliability are central. The data requires verification and validation in a more controlled way. The custody chain metadata provides means for verification that indeed, every access or transformation is in accordance with the construction chronology's semantics. Regular audits further enhance policy compliance regarding decay and reinforce the system's transparency, integrity, and accountability concerning preservation. All such elements contribute to the advancement of effective frameworks enabling enduring meaningful preservation solutions towards ICH motion capture.

### **Discussion**

The developing framework mitigates the issues of previously established methods and offers a holistic and strong technique to preserve motion-captured intangible cultural heritage (ICH) while ensuring its future accessibility and value. The lifecycle from ICH and its boundary preservation to motion capture technology functional encompasses several shifts of control and responsibility of data custodians, starting with lower-level pre-capture documentation and ending with long-term distribution. Interconnectivity of the custodial stages framed in the ICH life cycle complete with markers for authenticity, ethics, and critical heritage is highlighted in Figure 2. These steps and the phases of the process define the essence and value of the work.



**Fig. 2.** Conceptual framework for the preservation of intangible cultural heritage (ICH) using motion capture technologies. The model incorporates multimedia metadata, custody chain events, semantic web technologies, and intersectoral and interdisciplinary approaches for holistic value stratification to cross-disciplinary streams of preservation, ensuring lifelong fidelity and contextual accessibility.

### **Strengths of the Proposed Framework**

**Incorporating provenance and context:** This framework combines a respect des fonds-informed chain of custody mechanism and a semantic preservation storage system so that both the provenance

and context of motion capture data is maintained. Enhance authenticity and integrity: The chain of custody mechanism safeguards the data by providing a verifiable lineage which ensures, without tampering, the authenticity and integrity of the data. Detailed contextualization: The semantic preservation of ICH data explodes by capturing and representing intricate relationships, therefore understanding. Increased interoperability and reusability: The ontology and linked data standards provided increase the reusability and interoperability of the data which can be applied for varying uses. Long-term preservation: This framework comprehensively approaches the problem of data degradation, format obsolescence, and technological change concerning the long-term preservation of motion capture ICH.

## Conclusion

To safeguard an intangible cultural heritage using motion capture technologies, such strategies must include an integrated and comprehensive approach capable of overcoming the difficulties posed by documenting and protecting ephemeral traditions. This research has suggested an original approach that merges respect des fonds-informed chain of custody with semantic preservation. With this framework, data derived from the motion capturing of ICH will be preserved accurately, contextually, authentically, and made available for future use. This broadens the discourse within archival science and digital preservation technology towards the need for more effective and enduring approaches to manage the intangible heritage in the context of a deepening global surveillance memory infrastructure. Such an integrated strategy guarantees the long-term preservation of the vibrancy of these cultural treasures as active components of our collective heritage.

## References

- [1] UNESCO. (2003). Convention for the Safeguarding of the Intangible Cultural Heritage. United Nations Educational, Scientific and Cultural Organization. <https://ich.unesco.org>
- [2] Blake, J. (2017). Safeguarding Intangible Cultural Heritage: Challenges and Approaches. In *A Companion to Heritage Studies* (pp. 91–108). Routledge.
- [3] Bortolotto, C. (2020). *Intangible Cultural Heritage and the Museum: New Perspectives on Theory and Practice*. Berghahn Books.
- [4] Camurri, A., Coletta, P., Varni, G., Ghisio, S., & Volpe, G. (2016). Towards interactive social sharing of cultural heritage via motion capture. *ACM Journal on Computing and Cultural Heritage (JOCCH)*, 9(1), 1–21. <https://doi.org/10.1145/2806330>
- [5] Kenderdine, S. (2013). Embodiment, entanglement, and immersion in digital cultural heritage. In *A Companion to Digital Art* (pp. 367–387). Wiley-Blackwell.
- [6] Ng, H. C., Kamarol Zaman, Z., & Idris, S. (2023). Integrating motion capture with cultural context in Silat documentation. *Journal of Digital Heritage Technologies*, 6(2), 112–130.
- [7] Duranti, L., & Rogers, C. (2012). Trusting records in the cloud: The creation, management and preservation of trustworthy digital content. *Archives and Manuscripts*, 40(1), 1–18. <https://doi.org/10.1080/01576895.2012.668848>
- [8] Gladney, H. M. (2007). *Preserving Digital Information*. Springer. <https://doi.org/10.1007/978-3-540-68294-6>
- [9] Lavoie, B. F. (2014). *The Open Archival Information System (OAIS) Reference Model: Introductory Guide (2nd ed.)*. Digital Preservation Coalition. <http://dx.doi.org/10.7207/twr14-02>
- [10] Millar, L. (2010). *Archives: Principles and Practices*. Facet Publishing.
- [11] Doerr, M. (2003). The CIDOC conceptual reference model: An ontological approach to semantic interoperability of metadata. *AI Magazine*, 24(3), 75–92.
- [12] Heath, T., & Bizer, C. (2011). *Linked Data: Evolving the Web into a Global Data Space*. Morgan & Claypool. <https://doi.org/10.2200/S00334ED1V01Y201102WBE001>
- [13] Berners-Lee, T., Hendler, J., & Lassila, O. (2001). The Semantic Web. *Scientific American*, 284(5), 34–43. <https://doi.org/10.1038/scientificamerican0501-34>
- [14] PREMIS Editorial Committee. (2012). *PREMIS Data Dictionary for Preservation Metadata, Version 2.2*. Library of Congress. <https://www.loc.gov/standards/premis/>
- [15] Brinker, M., & Yaneva, M. (2021). Intangible heritage in the age of digital reproduction: Re-theorising authenticity. *International Journal of Heritage Studies*, 27(2), 163–181. <https://doi.org/10.1080/13527258.2020.1737910>
- [16] Pierazzo, E. (2016). *Digital Scholarly Editing: Theories and Practices*. Open Book Publishers. <https://doi.org/10.11647/OBP.0095>
- [17] National Digital Stewardship Alliance. (2019). *NDSA Levels of Digital Preservation (Revised)*. <https://ndsa.org/activities/levels-of-digital-preservation/>
- [18] Shankar, K., & Eschenfelder, K. R. (2020). Reframing digital preservation policies through community-centered values. *Archivaria*, 89, 26–59.
- [19] Gauthier, K., & Park, E. G. (2023). Developing community-driven metadata for digital heritage. *Journal of Documentation*, 79(1), 142–165. <https://doi.org/10.1108/JD-03-2022-0046>

