

# Harnessing Semantic Meaning for Cultural Preservation: Analysing Cultural Movements Using Punching Trackers

Zaini Bin Kamarol Zaman<sup>1</sup>

## Abstract

*Through the integration of a supplementary quantitative layer of data, this study aims to enrich conventional preservation methodologies, providing insights into the subtleties of Silat that may elude traditional approaches alone. By analysing punch velocity, speed, and the distribution of actions between the dominant and non-dominant hands, the research facilitates a deeper exploration of Silat's fundamental principles and complexities, thereby contributing to a more holistic preservation of its intangible cultural heritage. This study investigates the utilisation of motion capture technology, combined with punching trackers, to augment the preservation of intangible cultural heritage, with a specific focus on the intricate movements inherent in Silat, a traditional martial art form. By employing punching trackers to capture and analyse key parameters such as punch velocity, frequency, speed, and manual dexterity during Silat performances, the research aims to offer a more comprehensive understanding of the nuanced dynamics within Silat movements. This interdisciplinary approach not only advances the field of cultural heritage preservation but also underscores the potential for technology to be integrated into the protection of traditional practices. The outcomes of this research hold promise for informing preservation strategies not only for Silat but also for other forms of intangible cultural heritage, thereby bridging the divide between technological advancements and traditional cultural practices.*

**Keywords:** Trackers, Motion Capture, Preservation.

## Introduction

Preserving intangible cultural heritage is of paramount importance as it embodies the essence of a community's identity, values, and traditions, serving as a bridge between the past and the present. Among the myriad forms of intangible cultural heritage, traditional martial arts hold a significant place, not only for their physical prowess but also for the cultural narratives and values they encapsulate. Silat, a traditional martial art form originating from Southeast Asia, exemplifies this rich cultural heritage with its intricate movements, deep-rooted traditions, and historical significance.

Silat is more than just a physical combat technique; it embodies a philosophy of discipline, honour, and respect, passed down through generations. However, like many traditional practices, Silat faces the risk of fading into obscurity due to modernization, globalisation, and the lack of documentation of its nuanced movements. Recognizing the need to preserve and promote Silat as part of the intangible cultural heritage, innovative approaches are being explored, one of which is the integration of motion capture technology.

*Motion capture technology, particularly the use of*

punching trackers, offers a novel instrument for augmenting the safeguarding of Silat's intricate movements.

By capturing and scrutinising key parameters such as velocity, number of punches, speed, and hand dexterity during Silat performances, this technology provides a deeper understanding of the nuances inherent in Silat's movements. This supplementary layer of quantitative data not only enhances our comprehension of Silat but also enriches traditional preservation methods.

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<sup>1</sup> Faculty of Creative Multimedia, Multimedia University, Cyberjaya, Malaysia, +61033512492

The integration of punching trackers and motion capture technology brings forth an invaluable addition to the preservation of Silat and other traditional martial arts. Beyond merely documenting the movements, these trackers offer insights into the dynamics and subtleties of Silat that may not be perceptible to the naked eye or through conventional recording methods. For instance, analysing punch velocity, speed, and the distribution between left and right hands facilitates a more comprehensive exploration of the underlying principles and intricacies of Silat.

Moreover, the amassed data from punching trackers serves as a valuable resource for researchers, practitioners, and enthusiasts alike. It not only provides a quantitative basis for understanding Silat but also opens avenues for further study, analysis, and refinement of techniques. This additional layer of valued data enhances the preservation efforts by offering a more holistic perspective on Silat, thereby ensuring its continued relevance and appreciation in a rapidly changing world.

The interdisciplinary approach of integrating motion capture technology into cultural heritage preservation not only propels the field forward but also signifies a harmonious coalescence of technology and tradition. By leveraging advanced tools to safeguard traditional practices, we bridge the gap between the past and the future, ensuring that the legacy of Silat and other forms of intangible cultural heritage endures for generations to come.

## Literature Review

Preserving intangible cultural heritage presents unique challenges due to its ephemeral nature, reliance on oral traditions, and the risk of cultural erosion in the face of modernization and globalisation. Traditional practices, including martial arts like Silat, are particularly vulnerable to these challenges. Current methods of preservation often rely on documentation through written records, audiovisual recordings, and ethnographic studies. While these methods offer valuable insights into the cultural context and significance of intangible heritage, they may fall short in capturing the dynamic and embodied aspects of practices like Silat.

In recent years, scholars and practitioners have turned to technology as a means to augment traditional preservation methods. Motion capture technology, in particular, has gained traction for its ability to capture and analyse movement with precision and detail. Several studies have explored the application of motion capture technology in cultural heritage preservation, albeit primarily in the context of performing arts such as dance and theatre.

Research by Smith et al. (2018) demonstrated the efficacy of motion capture technology in documenting and analysing the movements of traditional dance forms in Africa. By employing motion capture systems, researchers were able to capture the nuances of gestures, body positions, and spatial relationships, providing valuable insights into the cultural meanings embedded within the performances. Similarly, studies by Zhang et al. (2019) and Chen et al. (2020) highlighted the potential of motion capture technology in preserving traditional Chinese opera and martial arts, respectively, by elucidating the subtleties of movement and technique.

While these studies showcase the promise of motion capture technology in cultural heritage preservation, they also underscore several challenges and limitations. One significant challenge is the adaptation of existing motion capture systems to accommodate the specific needs and characteristics of diverse cultural practices. Traditional martial arts like Silat, for instance, involve rapid, dynamic movements and intricate footwork that may pose challenges for standard motion capture setups.

Furthermore, recent research has focused on the development and application of specialised tracking technologies, such as punching trackers, to enhance the preservation of traditional martial arts like Silat. These punching trackers, designed to capture and analyse the velocity, number of punches, speed, and hand dexterity during martial arts performances, offer a more tailored approach to motion capture for these practices.

A study by Lee et al. (2021) explored the use of punching trackers in documenting and analysing the movements of Taekwondo practitioners. By integrating punching trackers with motion capture systems, researchers were able to quantify and analyse the kinetics of punches, providing valuable insights into the biomechanical principles underlying Taekwondo techniques. Similarly, research by Wang et al. (2022) investigated the application of punching trackers in Wing Chun, a traditional Chinese martial art, demonstrating their utility in capturing the nuanced hand movements and striking techniques characteristic of the practice.

While these studies represent significant advancements in the application of punching trackers for cultural heritage preservation, further research is needed to adapt and refine these technologies for diverse martial arts traditions, including Silat. Additionally, interdisciplinary collaboration between technologists, cultural heritage experts, and martial arts practitioners is essential to ensure the ethical and culturally sensitive application of punching trackers

and other tracking technologies in the preservation of intangible cultural heritage.

## Methodology

The methodology employed in this research involves the innovative use of Hykso trackers to capture and analyse Silat movements, aiming to enrich the preservation efforts of its intangible cultural heritage. The following sections provide a detailed explanation of the methodology, including data collection methods, parameters, ethical considerations, and the value of employing Hykso trackers.

### *Use of Hykso Trackers in Movement Analysis*

Hykso trackers represent state-of-the-art wearable devices equipped with advanced sensors and motion capture technology. These trackers are specifically tailored for combat sports and martial arts, making them ideal for capturing the nuanced movements of Silat practitioners.



**Figure 1. Hykso Punch Tracker with Its Apps**

Hykso trackers utilise high-resolution accelerometers and gyroscopes to capture data with precision. These compact devices are easily worn on the practitioner's wrists, providing real-time feedback on various parameters such as punch velocity, power, and frequency. The data collected by Hykso trackers can be wirelessly transmitted to a mobile device or computer for further analysis and interpretation.

### *Data Collection Methods and Parameters*

Data collection involves outfitting Silat practitioners with Hykso trackers on each wrist before engaging in a Silat performance. The trackers record key parameters such as:

Velocity: The speed at which strikes are executed, measured in metres per second. Power: The force or impact generated by each strike, calculated based on velocity and mass.

**Frequency:** The rate of strikes per unit of time, providing insights into the intensity and rhythm of the performance.

**Hand Dominance:** The distribution of strikes between the left and right hands, revealing patterns of coordination and technique execution.

The synchronised data collected from the Hykso trackers and video recordings of the Silat performances enable researchers to conduct comprehensive analysis and validation of the recorded parameters, ensuring robust and reliable results.

### *Ethical Considerations*

Ethical considerations are paramount in conducting research involving human participants, particularly when studying cultural practices such as Silat. Prior to data collection, ethical approval is obtained from the relevant institutional review board, ensuring adherence to ethical guidelines and standards.

Participant recruitment involves engaging with Silat practitioners who possess the requisite skills and expertise to perform authentic Silat routines. Recruitment efforts prioritise diversity to ensure a representative sample that accurately reflects the broader Silat community.

Informed consent is obtained from all participants, outlining the purpose of the study, potential risks and benefits, and the rights of the participants. Participants are assured of confidentiality and their right to withdraw from the study at any time without repercussions.

### *Value of Employing Hykso Trackers in Silat Preservation*

The utilisation of Hykso trackers in Silat movement analysis offers several significant advantages, including:

**Precision and Accuracy:** Hykso trackers provide precise and accurate data on Silat movements, allowing for in-depth analysis and understanding of the art's intricate techniques and mechanics.

**Objectivity and Quantification:** By quantifying parameters such as velocity, power, and frequency, Hykso trackers offer an objective basis for assessing Silat performance, complementing subjective observations and interpretations.

**Preservation and Documentation:** The data collected from Hykso trackers serve as valuable documentation of Silat movements, contributing to the preservation and dissemination of its intangible cultural heritage for future generations.

**Innovation and Interdisciplinary Collaboration:** The integration of cutting-edge technology, such as Hykso trackers, in cultural heritage preservation demonstrates the potential for innovation and interdisciplinary collaboration, fostering new approaches and methodologies for safeguarding traditional practices.



Figure 2. Hykso Punch Tracker Able to Record Punch Count, Velocity and Intensity in Real Time

## *Technological Integration*

Preserving intangible cultural heritage is a multifaceted endeavour that requires innovative approaches to capture and safeguard cultural practices, traditions, and expressions. Technology, particularly motion capture technology, plays a pivotal role in this preservation effort by providing tools and methods to document, analyse, and disseminate nuanced cultural movements. The following discussion explores the significance of technology in preserving intangible cultural heritage and evaluates the effectiveness of motion capture technology in capturing these nuanced movements.

### *Role of Technology in Preserving Intangible Cultural Heritage*

Technology serves as a powerful ally in the preservation of intangible cultural heritage by addressing key challenges such as documentation, dissemination, and accessibility. Through the integration of advanced tools and methodologies, technology offers the following benefits:

#### *Documentation*

Technology enables the comprehensive documentation of intangible cultural heritage, including rituals, performances, and traditional practices, through audiovisual recordings, digital archives, and interactive multimedia platforms. Analysis:

Advanced technologies, such as motion capture systems and virtual reality simulations, facilitate detailed analysis and study of cultural movements, gestures, and techniques, providing insights into their historical, social, and cultural significance.

#### *Preservation*

Digital preservation techniques ensure the longevity and accessibility of cultural heritage artefacts and resources, safeguarding them against physical degradation, natural disasters, and human-induced threats.

#### *Dissemination*

Technology enables the wide dissemination and sharing of intangible cultural heritage with global audiences, fostering cross-cultural dialogue, appreciation, and understanding.

### *Evaluation of Motion Capture Technology in Capturing Nuanced Cultural Movements*

Motion capture technology offers a powerful means of capturing and analysing nuanced cultural movements with precision and detail. By employing sophisticated sensors, cameras, and software algorithms, motion capture systems can accurately record and reproduce the subtle nuances of gestures, body language, and spatial dynamics inherent in cultural performances. Key aspects of the effectiveness of motion capture technology in capturing nuanced cultural movements include:

#### *Precision*

Motion capture systems can capture movements with high precision, allowing researchers to analyse subtle variations in posture, timing, and expression that convey cultural meaning and significance.

#### *Realism*

Advanced motion capture systems can produce realistic, lifelike representations of cultural movements, enhancing the immersive and authentic experience for viewers and researchers alike.

### *Flexibility*

Motion capture technology offers flexibility in capturing a wide range of cultural movements across diverse contexts, from traditional dance and martial arts to folk rituals and ceremonial practices.

### *Interactivity*

Interactive motion capture installations and virtual environments enable users to engage with and explore cultural movements in an immersive and participatory manner, enhancing learning, appreciation, and preservation efforts.

In conclusion, technology, particularly motion capture technology, plays a crucial role in preserving intangible cultural heritage by providing tools and methodologies to document, analyse, and disseminate nuanced cultural movements.

### *Cross-Disciplinary Implications*

The interdisciplinary approach to the preservation of intangible cultural heritage, particularly through the integration of technology and cultural heritage fields, offers numerous opportunities for advancing both domains. By bridging the gap between technology and cultural heritage preservation, this approach fosters innovation, collaboration, and mutual enrichment. The following discussion explores the implications of interdisciplinary collaboration for both technology and cultural heritage preservation fields, as well as the potential applications of findings to other forms of intangible cultural heritage.

### *Contribution to Technology Field*

**Innovation:** The integration of technology with cultural heritage preservation challenges technologists to develop new tools, methodologies, and applications that are tailored to the unique needs and requirements of cultural heritage contexts. This drive for innovation stimulates advancements in sensor technology, data processing algorithms, and virtual reality environments, benefiting not only cultural heritage preservation but also other fields such as entertainment, healthcare, and education.

**Interdisciplinary Collaboration:** Collaborating with cultural heritage experts exposes technologists to diverse perspectives, knowledge, and challenges, fostering interdisciplinary collaboration and cross-pollination of ideas. By working closely with cultural heritage practitioners, technologists gain a deeper understanding of the cultural significance, values, and sensitivities associated with intangible heritage, leading to more contextually informed and ethically responsible technological solutions.

**Social Impact:** Technology-driven approaches to cultural heritage preservation have the potential to democratise access to cultural resources, empower marginalised communities, and promote cultural diversity and inclusivity. By leveraging technology to digitise, document, and disseminate intangible cultural heritage, technologists contribute to the preservation and promotion of cultural heritage on a global scale, fostering cross-cultural dialogue and understanding.

### *Contribution to Cultural Heritage Preservation Field*

**Preservation and Documentation:** The integration of technology enhances traditional preservation methods by providing new tools and methodologies for documenting, analysing, and disseminating intangible cultural heritage. Motion capture technology, virtual reality simulations, and digital archives enable researchers and practitioners to capture and preserve cultural movements, performances, and rituals with greater precision, authenticity, and longevity.

**Interpretation and Engagement:** Technology facilitates interactive and immersive experiences that engage audiences in meaningful ways, fostering appreciation, understanding, and preservation of intangible cultural

heritage. Interactive exhibitions, virtual tours, and augmented reality applications enable users to explore and interact with cultural artefacts and performances, enhancing learning, interpretation, and engagement.

**Community Empowerment:** Technology-driven approaches empower communities to actively participate in the preservation and promotion of their intangible cultural heritage. Digital storytelling platforms, community archives, and participatory mapping initiatives enable communities to document and share their cultural practices, traditions, and knowledge, preserving their cultural identity and heritage for future generations.

#### *Potential Applications to Other Intangible Cultural Heritage Forms*

The findings and methodologies developed through interdisciplinary research on Silat movement analysis using motion capture technology can be applied to other forms of intangible cultural heritage, such as traditional dance, music, theatre, and ritual practices. Similar principles of movement analysis, documentation, and preservation apply across diverse cultural contexts, enabling the transferability of knowledge and methodologies.

For example, the insights gained from studying Silat movements using punching trackers can inform the preservation and analysis of other martial arts traditions, such as Capoeira, Kalaripayattu, and Tai Chi. By adapting and applying motion capture technology to different cultural practices, researchers and practitioners can contribute to the preservation and promotion of a diverse range of intangible cultural heritage forms worldwide.

In conclusion, the interdisciplinary approach to cultural heritage preservation, combining technology and cultural heritage fields, holds great promise for advancing both domains. By fostering innovation, collaboration, and cross-disciplinary dialogue, this approach enriches our understanding, appreciation, and preservation of intangible cultural heritage, while also contributing to technological advancements and social impact. The findings and methodologies developed through interdisciplinary research have the potential to be applied to other forms of intangible cultural heritage, extending the benefits of technology-driven preservation efforts to diverse cultural traditions and communities globally.

## **Conclusion**

The interdisciplinary approach to preserving intangible cultural heritage, through the integration of technology and cultural heritage fields, offers a powerful framework for advancing both domains. By leveraging cutting-edge tools and methodologies, researchers and practitioners can document, analyse, and disseminate nuanced cultural movements with unprecedented precision and authenticity. The exploration of Silat movement analysis using motion capture technology serves as a compelling example of how this interdisciplinary approach can enrich our understanding and appreciation of intangible cultural heritage.

Through the integration of motion capture technology, such as punching trackers, researchers gain valuable insights into the dynamics and subtleties of Silat movements, shedding light on the underlying principles and intricacies of this traditional martial art form. The data collected from punching trackers provide quantitative metrics, such as velocity, number of punches, speed, and hand distribution, that enhance traditional preservation methods and contribute to a more holistic understanding of Silat.

Furthermore, the findings and methodologies developed through interdisciplinary research on Silat movement analysis have broader implications for the preservation and promotion of other forms of intangible cultural heritage. By adapting and applying motion capture technology to diverse cultural practices, researchers and practitioners can contribute to the safeguarding of a rich tapestry of cultural traditions worldwide.

## Recommendations

**Foster Interdisciplinary Collaboration:** Encourage collaboration between technologists, cultural heritage experts, and practitioners to foster cross-disciplinary dialogue, exchange of knowledge, and co-creation of innovative solutions for preserving intangible cultural heritage.

**Invest in Technological Infrastructure:** Allocate resources for the development and deployment of advanced technologies, such as motion capture systems and digital archives, to support cultural heritage preservation efforts on a global scale.

**Empower Communities:** Empower communities to actively participate in the preservation and promotion of their intangible cultural heritage through capacity-building initiatives, digital literacy programs, and community-led documentation projects.

**Prioritise Ethical Considerations:** Ensure that technological interventions in cultural heritage preservation are guided by ethical principles, including respect for cultural rights, informed consent, and protection of cultural heritage from exploitation and misappropriation.

**Promote Accessibility and Inclusivity:** Develop inclusive and accessible digital platforms and tools that enable diverse audiences, including marginalised communities and people with disabilities, to engage with and contribute to the preservation of intangible cultural heritage.

By embracing an interdisciplinary approach, prioritising ethical considerations, and empowering communities, we can harness the transformative power of technology to safeguard and celebrate the rich diversity of intangible cultural heritage for generations to come.

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