IDEALOGY
JOURNAL

Digital Micro Visualzation of Movements through Motion Capture: A Case Study of *Joget Serampang Laut*

*Mohd Firdaus Mohd Herrow[1], Nur Zaidi Azraai[2]

*[1]Centre for Diploma Studies, Universiti Tun Hussein Onn Malaysia (UTHM), Johor, MALAYSIA.
[2]School of The Arts, Universiti Sains Malaysia (USM), Penang, MALAYSIA.

*[1]firdaushmh@uthm.edu.my, [2]nurzaidi@usm.my
*Corresponding author

ABSTRACT

Motion capture technology also known as MoCap is one the important and leading technology in the process of capturing, recording and digitizing a significant movement. It gives a high accuracy of movement information, high degree freedom in movement and high flexibility in the captured physical movement. A wide range of research uses motion capture technology to gather data and to create a new finding in sport, medical and military purposes to improve human activities. Recently, in the area of performing arts, a number of research has used this technology, especially to capture the movement of traditional dance and traditional martial art as a platform of perseveration, documentation, archiving and interactive learning material purposes. This paper was executed using a mix of qualitative and quantitative methodology. Interviews and literature reviews were used to expose the rich diversity of three elements: Joget Serampang Laut, art biomechanics and motion capture technology. On the other hand, 21 joint of art biomechanics and 42 set of optical tracking passive markers were placed on the dancer to record the dance routine of Joget Serampang Laut in a motion capture laboratory that used eight (8) unit Osprey digital motion capture camera. Cortex Analysis software was used as a form of data analysis instrument. The findings of the research included motion capture technology as an effective tool for synthesizing time-based trajectory information into single frame, time-independent images that contained useful information about movements and gestures. Micro visual images can be essential as a metaphor for human experience since it provides objective representation that informs human perception and stimulates interpretations. At the end of the research, micro visual can be a communicative content related to bodyline that contains implicit meaning. The gestural representation may be understood in an experiential or cultural denotation and connotation that can holistically benefit and enhance the cultural values.

1 INTRODUCTION

In today's world, the development of technology has become a crucial factor in numerous sectors, and many areas heavily rely on technological advancements to function. The use of technology to address different issues has resulted in positive and constructive impacts on society. The successful resolution of many issues and problems has been possible with the aid of technology. One important issue that requires attention and participation is the preservation of national heritage through digital culture preservation. In cultural studies, tangible and

intangible cultural heritage are key subject matters, and technology has become a vital medium in accomplishing UNESCO's mission, vision, and targets. The use of modern technology as a digital platform has increased ease of accessing and collecting valuable cultural knowledge from different ethnic groups. This has created a gateway for the young generation to learn about their cultural heritage and promote sustainable human development as ethnic coherence (Themistocleous, 2018; Santachiara et al., 2018; Demenchuk et al., 2020; Elfizar et al., 2020).

According to Idris et al. (2017), the quality of digital heritage is dependent on the appropriate use of digital media, tools, and software. Careful consideration and integration must be given to what, when, and how these components are utilized to ensure the desired level of quality. Precise decision-making regarding the use of these components is essential for digital preservation.

Kico et al. (2018) discussed the various methods available in teaching dance, including text documentation, photos, video, and graphical notation. This method is considered attractive, aesthetic and pleasant to watch. However, common methods like photography and videography can only capture visible movements, resulting in incomplete information and accuracy details of movement.

According to Syu et al. (2018), digital preservation of cultural assets is a critical area that has been aided by the development of digital technology, noting that motion capture technology is a leading medium for archiving information on body motion and movement. The process of gathering valuable data on dance movement that is not visible to the naked eye can be greatly enhanced by advanced technology such as motion capture. This technology is able to record and translate any kind of movement into specific algorithms, allowing for in-depth analysis and transformation into new findings in a 3D space.

2 MOTION CAPTURE TECHNOLOGY

In the realm of digital data capture and transformation, motion capture technology or MoCap is a vital technology used to record body and object movements, creating rich 3D digital information that is accurate and useful in many different applications. This technology enables the capture of previously invisible movements, providing valuable information in the form of trajectory lines. This technology facilitates the display of performance characteristics and enhances data analysis.

According to Krigslund et al. (2012) and Yunus et al. (2021), motion capture is an advanced technology that has been used in many fields, including medicines, sports, entertainment, gaming, and performing arts. The technology has brought a new level of realism in providing valuable information. Its ability to capture motion and expression with precision is a big advantage, providing users with an ultra-realistic and immersive experience in order to better understand certain subject matter.

Motion capture technology is a versatile tool that enables the recording of analogical motion, which can be converted into detailed digital data for use in a wide range of applications. By providing a comprehensive and accurate representation of performance characteristics, 3D digital information is particularly well-suited for scientific analysis and structured data collection. Additionally, motion capture technology offers unique benefits for the digitization of intangible cultural heritage assets, including enhanced preservation, improved learning outcomes, and increased potential for use in animation and other creative endeavours. This

technology represents a superior alternative to traditional methods such as text, 2D images, and videos.

2.1 Motion Capture Technology Purpose in Digital Preservation

Digital preservation, through the utilization of motion capture technology is largely and primarily centred on education, training, and entertainment purposes. Applications such as interactive learning, 3D storytelling, and video instruction training offer new and engaging ways for learners to experience and practice unique traditional dance movements or performances to fulfil the primary objective of digital preservation (Stavrakis et al., 2014; Kovavisaruch et al., 2011; Mustaffa & Idris, 2017).

According to Mohd Herrow and Azraai (2021), the application of motion capture technology as a platform to explore traditional Malay folk dance movement can provide significant benefits in preserving culture and heritage. The exploration of motion capture technology as a platform to delve into the micro visual of traditional Malay folk dance movement has the potential to provide significant benefits for culture and heritage preservation. These benefits include an increase in cultural value and meaning, and the appreciation of the arts can be enhanced in a holistic manner.

Micro visualization study utilizing and integrating motion capture technology is a novel approach that can bring a new level of visual significance to the Malay traditional dance by capturing the intricate and delicate movements used to convey meaning and narrative by gaining a deep understanding and reflection of the cultural, historical, and philosophical context in every dance style. Figure 1 shows the framework of motion capture technology as a variation of potential purposes in digital preservation.
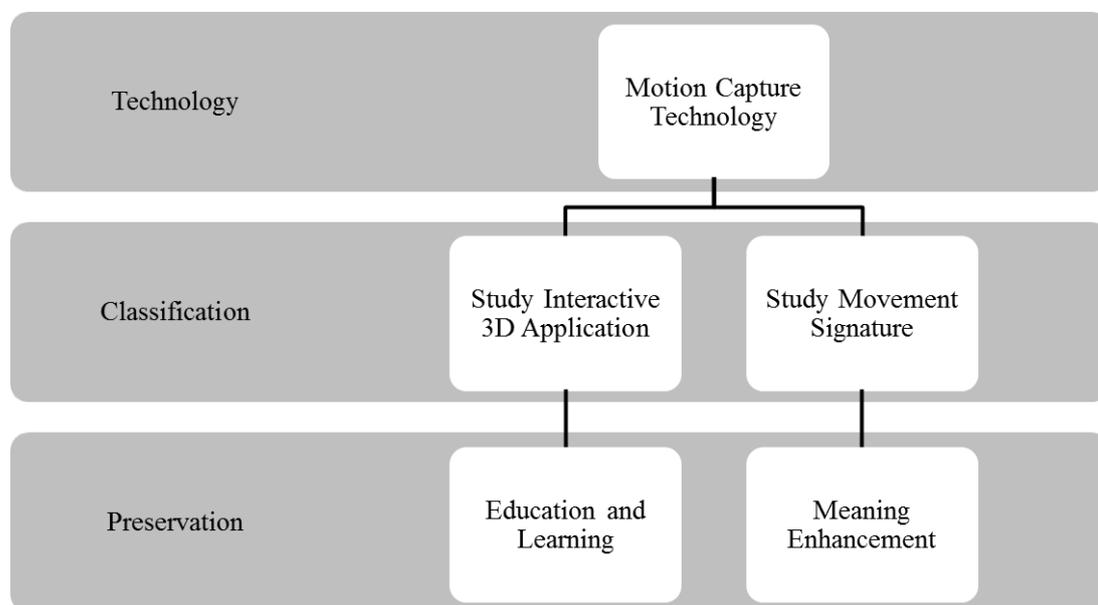

Figure 1 Framework of Variation Purpose of Motion Capture Technology

2.2 Art Biomechanics in Malay Folk Traditional Dance

The application of art biomechanics is vital in providing an analytical description and quantification of the components of movement, such as forces, velocity, and acceleration of body movement. The specific data captured through this analysis can be used to develop personalized training plans, improve athletic performance, and prevent injuries. In dance, biomechanics is focused on gathering information about the joints and rigid segments of each body part, which are fundamental for the exploration and analysis in common study.

According to Wilson and Kwon (2008) and Van der Kruk and Reijne (2018), analysis of motion using 3D motion technology involves capturing movement from multiple angles, allowing for a more comprehensive understanding of the body's movement. Motion analysis involves the use of tracking software and multiple motion capture cameras, typically ranging from two (2) to six (6) or more, to capture and record movements for the analysis of body segments in specific body parts or the overall frame of the dancer's body. The use of motion analysis in dance enables a deeper understanding of movement patterns, which can be used to enhance teaching, learning, and performance. In addition to improving dance, the data obtained from motion analysis can also be used to enable a deeper understanding of movement patterns, and to preserve and document cultural heritage through visual representation.

Art biomechanics in Malay folk traditional dance is commonly divided into two (2): main body joints that provide with significant movement, which are the upper body and lower body. Upper body movements are commonly perform in an organic or free form as a popular element in Malay folk dance, and are known for exhibiting distinct characteristics based on gender, with male and female dancers each showcasing their own unique approach and motion style to represent their characteristic.

The lower body movement most commonly uses symmetrical balance as the concept in order to emphasize stability, unity and harmony. According to Wan Muhammad Fauzan and Said Husain (2018), symmetrical patterns are an essential component of Malay folk dance, with the opening and ending phases of the dance often incorporating the same floor pattern movements to create a sense of symmetry and balance, such as form of linear shapes, including vertical, horizontal, geometry, semi-circular or circular.

3 METHODOLOGY

In this study, the qualitative research approach utilized a semi-structured interview approach with focus groups comprising of expert practitioners and philosophers in related areas. The goal was to gather valuable information on the Malay *Joget Serampang Laut* dance, including its fundamental components, representation, and terminology, to aid a better understanding of the dance. Data collection for this study also involved using participant observation as a method. This entailed observing the Malay *Joget Serampang Laut* step movements for each *Ragam*, the biomechanics of each movement, and how dancers represented the movement art biomechanics. Through contest analysis, the raw information obtained from both methods was synthesized to gain a comprehensive understanding of Malay *Joget Serampang Laut*. This process allowed the researcher to delve into the history, fundamental components, representation of the dance movement, *Joget Serampang Laut* step pattern for each *Ragam*, and art biomechanics that played a crucial role in dynamic movement.

On the other hand, for the quantitative research approach, the utilization of advanced technology, particularly motion capture, was a crucial aspect of the research to capture, record,

digitize, and visualize the movements of the Malay *Joget Serampang Laut* dance. This approach was central to the research as it provided a micro-visual representation of the dance movements that were typically imperceptible to the human eye. In the motion capture laboratory at the School of Arts, Universiti Sains Malaysia, eight (8) units of Osprey digital camera motion capture were mounted on rails. These cameras had a 245 frame per second capability and a 640 x 480-pixel sensor. Calibration and synchronization of the cameras and software were necessary before recording any motion to ensure alignment with the capture volume, resulting in highly accurate data collection. Furthermore, 42 passive markers were placed on the performer based on specific body joints to provide a sophisticated and unique set of motion data. Cortex motion analysis software was used for data analysis in order to generate lines, patterns, tracking markers, and duration from the performance data. A specific procedure was adhered to for a smooth process. Once the recording was completed, a raw motion signature of *Joget Serampang Laut* appeared in the system, undergoing several stages of analysis, including cleaning up markers data, converting marker to joint angles, and reframing trajectory line. Figure 2 shows the conceptual framework of the research for each research objectives.
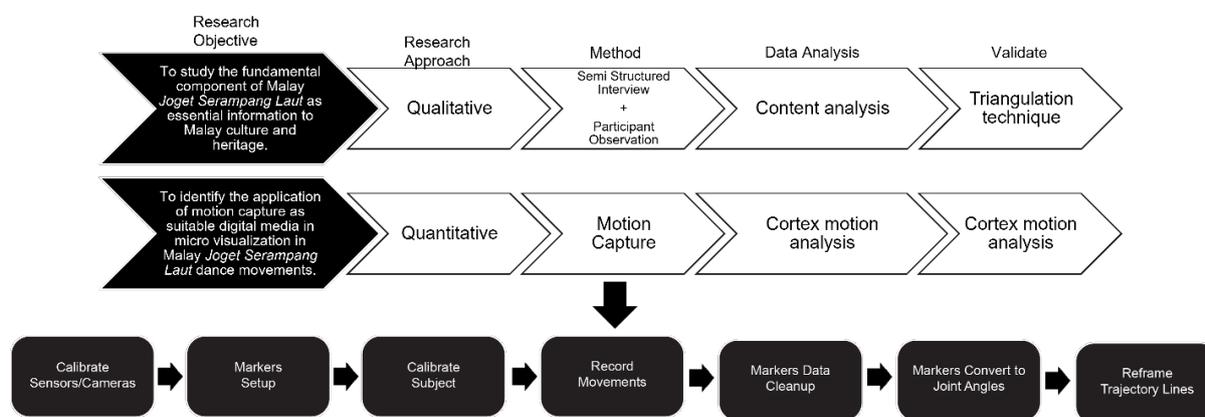

Figure 2 Conceptual Framework of the Research

4 FINDINGS

Malay folk dance is a unique cultural expression that is closely tied to the customs and traditions of specific regions, religions, and beliefs. The performance of these dances is typically reserved for significant occasions, such as weddings, festival celebrations, and religious ceremonies, highlighting their cultural importance. It serves as a means of commemorating significant events and occasions, as well as showcasing the community's creativity, spirituality, and shared identity. Thus, Malay folk dance is an essential component of the rich cultural fabric of the Malay people, representing their history, mythology, and beliefs. Its cultural codes, history, and symbolism make it a unique form of artistic expression that is integral to the community's identity and development.

The genesis of *Joget Serampang Laut* can be traced back to the 1970s, when Seid Manaf, an expert, practitioner and teacher of traditional Malay folk dance, pioneered the art form's evolution at *Taman Budaya* also known as *Komplek Budaya Negara* in 1972. His deep involvement in and dedication to the development of Malay folk dance in Malaysia, particularly in the Joget style, was pivotal in shaping the genre's unique characteristics and establishing it as an integral part of the country's cultural identity. Noriah Ahmad and the late Zulkifli Zain, who were mentored by the late Seid Manaf, are widely regarded as the pioneers

of *Joget Serampang Laut*. As the first generation to inherit the theoretical and practical knowledge and skills of this traditional Malay folk dance from their esteemed mentor, they have played a significant role in preserving and advancing the art form's cultural heritage.

4.1 Fundamental Component of Joget Serampang Laut

Bannerman (2014) and Koff (2015) have identified four (4) fundamental components that are crucial to the creation of Malay folk dance: dance movement, music, musical instruments, and costume, all of which are considered to be equation elements. But, Noriah Ahmad, expert and experience practitioner of *Joget Serampang Laut*, has identified five (5) necessary and fundamental components for the performance of *Joget Serampang Laut*. These elements include four (4) similar elements to Malay folk dance, namely dance movement, music, musical instruments, and costume, as well as a new element, which is the lyrics. Each of the fundamental components in *Joget Serampang Laut* plays an important role in making the dance routine's harmony, unity and synchronization.

However, the primary area of focus in this research was the dance movement of *Joget Serampang Laut*. It consisted of 14 *Ragam* performed by one (1) pair group of performers with specific duration of three (3) minutes and 40 seconds. This provided a whole set of dance step pattern and visual representation of *Joget Serampang Laut*. Figure 3 shows the fundamental component of *Joget Serampang Laut*.
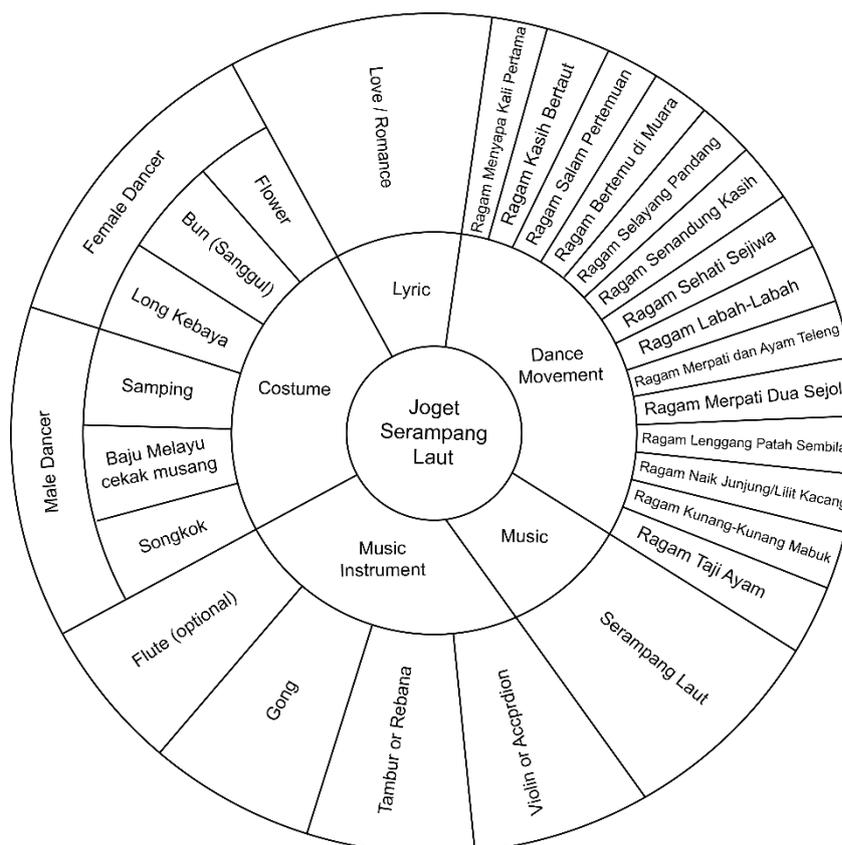

Figure 3 Fundamental Component of *Joget Serampang Laut*

4.2 Art Biomechanics of Joget Serampang Laut

Joget Serampang Laut, a dance form that is known for its energetic movements, holds the value of gentility and morality as a crucial aspect of Malay culture. In this dance, the emphasis on grace and propriety is a testament to the enduring importance of traditional customs and manners in the community. By prioritizing these values in the practice of *Joget Serampang Laut*, the Malay people continue to honour and preserve their cultural heritage while celebrating their vibrant spirit and enjoyment of life.

The creation of *Joget Serampang Laut* drew inspiration from three key sources: nature (*Alam*), Islamic principles, and Malay customs. These influences are reflected in the dance's movements, which blend graceful gestures with lively steps to capture the essence of the natural world while expressing the deep spirituality and cultural richness of the Malay community.

The focal point of *Joget Serampang Laut* lies in the lower body and upper body, where the majority of the routine is defined through profound movement. The foot and ankle play a key role in expressing the artistry of the dance, allowing for a stunning visual display. Geometrical shapes are the foundation of the dance floor pattern in this style of dance, with a range of shapes, including squares, diamonds, circle, and triangles, forming the main structure of the dance movement.

The upper body is heavily involved, with a focus on using the elbow, shoulder, and wrist to execute the dance movements and add a level of complexity to the routine by creating an intricate, dynamic and expressive and visually appealing movements. The usage of organic and free-form movements is inspired by *Alam*, such as *mendayung, mengail,* and *lilit kacang*. These types of movements add an element of naturalness and creativity to the routine, resulting in a visually stunning and artistically expressive dance performance. Figure 4 shows the main art biomechanics involved in *Joget Serampang Laut*.

Figure 4 Active Art Biomechanics in *Joget Serampang Laut*

4.3 Micro Visual of Joget Serampang Laut

Under the guidance and control of expert practitioners, the *Joget Serampang Laut* dance routine was meticulously recorded 10 times to ensure the utmost accuracy and precision. To track movement and motion accurately, a total of 21 passive markers were strategically placed on the performer's body at specific joints, with four (4) markers affixed to the head, 11 markers to the upper body, and six (6) markers to the lower body.

The micro visual was grounded in active art biomechanics, which involved the strategic placement of 21 markers on the performer's body to capture a range of movements and create various trajectories that intersect, overlap, and diverge. The resulting visual was composed of 336 individual joint segments that formed a dynamic pattern. It consisted of an intricate and multifaceted arrangement of lines, shapes and forms that coalesced to form a breathtakingly captivating and visually compelling display, imbued with an unparalleled level of immersion. This assemblage of raw data represented a priceless asset to study visual culture, providing a distinct vantage point from which to contemplate the aesthetics of motion and the philosophical nuances of appreciation and comprehension.

Moreover, this raw data also held significant potential for philosophical understanding and appreciation, providing a platform to contemplate the subtle distinctions of aesthetics. Through a careful analysis of the elaborate details of this micro visual into philosophical and aesthetic preceptive, a rich tapestry of information was sure to captivate and inspire, creating a profound and deeply moving with deeper experience. Figure 5 shows the result micro visual of *Joget Serampang laut* through motion capture technology.
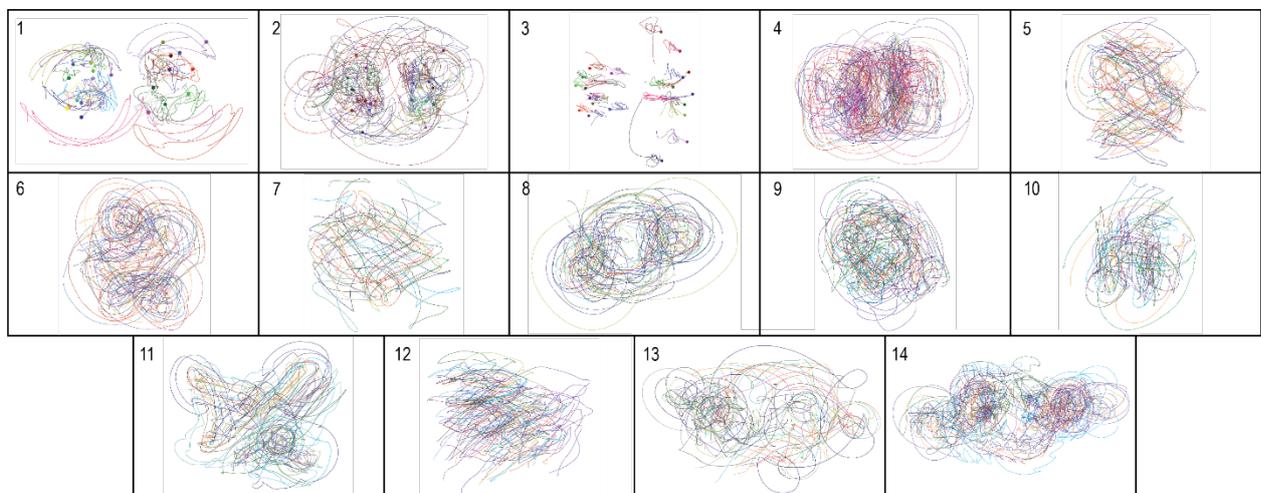

Figure 5 Micro Visualization of *Joget Serampang Laut*

5 DISCUSSION

Joget Serampang Laut provides a powerful visual display of aesthetic, unity, harmony and modesty, reflecting the strong connection between the performers. The use of structured and coordinated choreography underscores the significance of collective movement and harmony among the dancers, conveying a sense of aesthetic beauty and unity. The creation of *Joget Serampang Laut* drew inspiration from three (3) key foundations: *Alam*, Islamic principles, and Malay customs. This unique intermingling of influences is reflected in the dance's movement profound structure, which emphasises on aesthetic beauty, unity, modesty and harmony to

continue to captivate audiences worldwide. The statement highlights the fact that the influence of Malay community culture has continued to be evident in various aspects of life. One (1) of the key features of this culture is the deep connection between humans, nature and spiritualty, which is reflected in the form of various traditions, beliefs and practices. The Malay culture has a rich history of living in harmony with the environment, valuing the interdependence between humans and the natural world.

The usage of art biomechanics in *Joget Serampang Laut* adds an important dimension to the art of dance by creating a diverse range of motion signatures, and providing a quantifiable visual element to the dance routine. This not only enhances the artistry of the dance, but also has important implications for the study of dance as a discipline, allowing for improved analysis and understanding of the physical aspects of dance performance. One (1) of the significant benefits of incorporating art biomechanics into the dance is the ability to generate a unique and captivating experience for both performers and audiences. Utilizing biomechanics principles enables execution of the movements with greater precision and control. It results to an engaging and impressive visual appearance.

Motion capture technology has emerged as a revolutionary tool in the preservation of cultural heritage. The digitization and visualization of micro visuals of traditional dances, such as *Joget Serampang Laut*, have become possible with the utilization of this technology. Its high degree of metadata accuracy and freedom in movement provide a robust platform for learning materials, supporting sustainable human development and contributing to the preservation and transmission of cultural heritage for future generations in the most comprehensive and accurate way possible. Figure 6 shows the principle and interconnection for micro visualization.
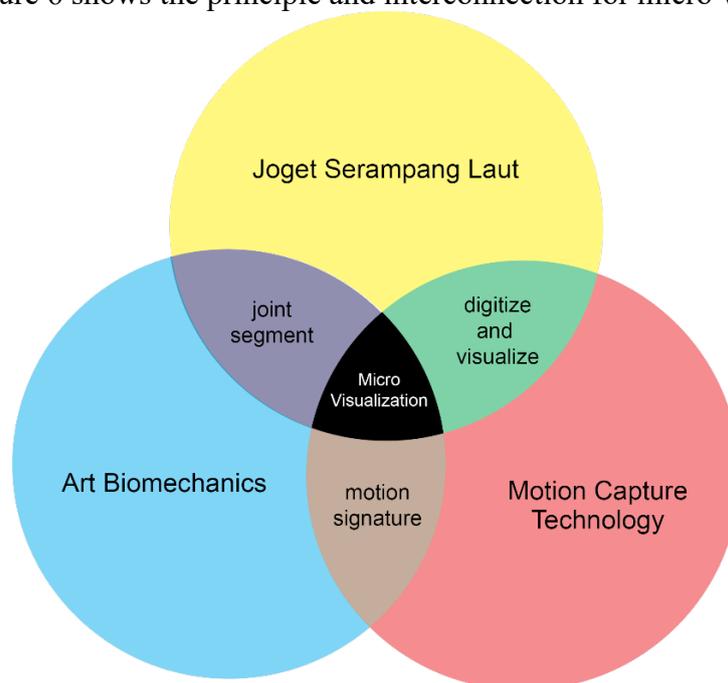

Figure 6 Framework of Micro Visualization in *Joget Serampang Laut*

6 CONCLUSION

This research can act as a connection that will enhance the appreciation and understanding of the philosophy behind any Malay folk dance in the country. Additionally, exploring the micro visual elements of *Joget Serampang Laut* has the potential to enhance the existing

philosophy. Furthermore, these micro visual aspects can be examined in terms of their symbolism, movement patterns, and cultural significance to potentially provide a new paradigm or expand meaning that can profoundly impact the understanding, appreciation, and ethnic development of the culture.

Through motion capture technology, micro visualizations can be captured to communicate content related to the bodyline, containing implicit meaning. By analysing the denotation and connotation of these visual elements, gestural representation can be understood experientially or culturally, offering deeper insights into the meaning of these traditional Malay performing arts. The use of motion analysis data has become increasingly prevalent in various fields, including dancing due to its multifaceted nature. One (1) of the primary applications in motion analysis data is in enhancing performance, as it allows for a more in-depth understanding towards the philosophy of the dance, patterns and art biomechanics.

Moreover, motion analysis technology provides unique insights into cultural heritage as the technology continues to evolve, become more accessible, and offer new opportunities for the cultural growth and discovery. Figure 7 shows the possibility of micro visualization that can enhance the definition to the existence or provide an extended definition that can growth into new paradigm of understanding and appreciation.
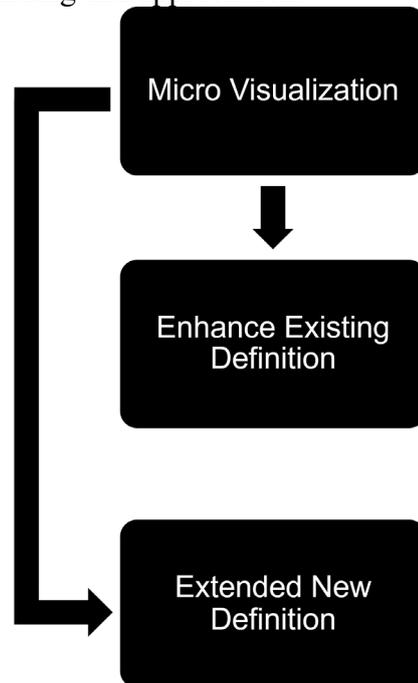

Figure 7 Potential Micro Visual as Enhancement Definition or as Extended Definition

The use of motion capture technology in *Joget Serampang Laut* dance provides a medium for discovering micro visual elements and symbols within dance movement. Micro visualization can be a valuable asset in enhancing the existing definitions or extending new definitions in *Joget Serampang Laut*. By breaking down the complex movements and patterns of the dance into smaller components, researchers or practitioners can gain deeper insights into the cultural, philosophical and historical significance, and even generate new perspective of *Joget Serampang Laut*. This research focused on enhancing cultural meaning holistically, benefiting young generation and creating a bridge for cross-cultural ideas and development. By identifying the root or origin of the culture, a sense of unity and belonging can be established by generating new interests, and enhancing and expanding into other fields of study.

ACKNOWLEDGEMENTS

FUNDING

AUTHOR CONTRIBUTIONS

All authors played equal contribution to the production of this manuscript.

CONFLICT OF INTEREST

There are no conflicts of interests.

REFERENCES

Azraai, N. Z., Sabran, K., & Mat Jusoh, C. (2018). *The Art of Silat: Mapping the Trajectory Lines for Hidden Symbols*. *207*(Reka), 372–374. https://doi.org/10.2991/reka-18.2018.82

Bannerman, H. (2014). Is dance a language? Movement, meaning and communication. *Dance Research*, *32*(1), 65–80. https://doi.org/10.3366/drs.2014.0087

Demenchuk, E., Camelia Ilies, D., Wendt, J. A., Koroleva, Y., Ilies, A., Goikhman, A., Maznitsyna, E., Caciora, T., Herman, G., & Bilcec, M. (2020). *Spectroscopy Study Of Heritage Objects For The Digitization Of Cultural Heritage* (Vol. 19, Issue 6). http://www.eemj.icpm.tuiasi.ro/;http://www.eemj.eu

Elfizar, Sukamto, Fitriansyah, A., Sastria, G., & Erna, M. (2020). Preserving Riau's Malay Culture Through Virtual Environment Application. *IOP Conference Series: Earth and Environmental Science*, *519*(1). https://doi.org/10.1088/1755-1315/519/1/012019

Herrow, M. F. M., & Azraai, N. Z. (2021). Digital Preservation of Intangible Cultural heritage of Joget Dance Movement Using Motion Capture Technology. *Int. J. Herit. Art Multimed*, *4*, 1-13. https://doi.org/10.35631/IJEPC.432002

Idris, M. Z., Mustaffa, N., Othman, A. N., & Abdullah, M. F. W. (2017). Exploring Principle Components for Digital Heritage Preservation on Malay Folk Dances. *International Journal of Academic Research in Business and Social Sciences*, *7*(10), 738–747. https://doi.org/10.6007/ijarbss/v7-i10/3429

Kico, I., Grammalidis, N., Christidis, Y., & Liarokapis, F. (2018). Digitization and visualization of folk dances in cultural heritage: A review. *Inventions*, *3*(4). https://doi.org/10.3390/inventions3040072

Koff, S. (2012). Towards a Definition of Dance Education. Article in Childhood Education, 77(1), 27. Doi: 10.1080/00094056.2000.10522134

Kovavisaruch, L., Wisanmongkol, J., Sanpachuda, T., Chaiwongyen, A., Wisadsud, S., Wongsatho, T., Tangkamcharoen, B., Nagarachinda, B., & Khiawchaum, C. (2011). Conserving and promoting Thai sword dancing traditions with Motion Capture and the Nintendo Wii. *PICMET: Portland International Center for Management of Engineering and Technology, Proceedings*, *January 2011*.

Krigslund, R., Dosen, S., Popovski, P., Dideriksen, J. L., Pedersen, G. F., & Farina, D. (2012). A novel technology for motion capture using passive UHF RFID tags. IEEE Transactions on Biomedical Engineering, 60(5), 1453-1457.

Mustaffa, N., & Idris, M. Z. (2017). Accessing Accuracy of Structural Performance on Basic Steps in Recording Malay Zapin Dance Movement Using Motion Capture Accessing Accuracy of Structural Performance on Basic Steps in Recording Malay Zapin Dance Movement Using Motion Capture. *Journal of Applied Environmental and Biological Sciences*, *January*, 165–173.

Santachiara, M., Gherardini, F., & Leali, F. (2018). An Augmented Reality Application for the Visualization and the Pattern Analysis of a Roman Mosaic. *IOP Conference Series: Materials Science and Engineering*, *364*(1). https://doi.org/10.1088/1757-899X/364/1/012094

Shan, G., Visentin, P., & Harnett, T. (2010). A Novel Use of 3D Motion Capture: Creating Conceptual Links between Technology and Representation of Human Gesture in the Visual Arts. *Leonardo*, *43*(1), 34–42.

Stavrakis, E., Aristidou, A., Savva, M., Himona, S. L., & Chrysanthou, Y. (2012). Digitization of Cypriot Folk Dances. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, *7616 LNCS*, 404–413. https://doi.org/10.1007/978-3-642-34234-9_41

Syu, Y. S., Chen, L. O., & Tu, Y. F. (2018). A case study of digital preservation of motion capture for Bā Jiā Jiāng performance, Taiwan religious performing arts. In *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics): Vol. 11197 LNCS*. Springer International Publishing. https://doi.org/10.1007/978-3-030-01765-1_12

UNESCO. (2019). Operational Guidelines for the Implementation of the World Heritage Convention. Paris: UNESCO World Heritage Centre.

Van der Kruk, E., & Reijne, M. M. (2018). Accuracy of human motion capture systems for sport applications; state-of-the-art review. European journal of sport science, 18(6), 806-819.

Wan Muhammad Fauzan, W. M. A., & Said Husain, S. K. (2018). Geometri dalam Tarian Zapin. *Asian Journal of Environment, History and Heritage*, *2*(2), 331–342.

Wilson, M., & Kwon, Y. H. (2008). The Role of Biomechanics in Understanding Dance Movement. *Journal of Dance Medicine & Science*, *12*(3), 109–116.

Yunus, M. N. H., Jaafar, M. H., Mohamed, A. S. A., Azraai, N. Z., & Hossain, M. S. (2021). Implementation of kinetic and kinematic variables in ergonomic risk assessment using motion capture simulation: A review. *International Journal of Environmental Research and Public Health*, *18*(16), 8342.