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# Application of motion capture technology in the digital recreation of Tang Dynasty mural art: a case study of Han Xiu's Tomb

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**Abstract:** This study employed motion capture technology to digitally restore the murals of Han Xiu's Tomb from the Tang Dynasty. The aim was to enhance audience engagement and understanding of Tang Dynasty cultural traditions through a multi-dimensional digital media display. Using the knowledge framework of Tang Dynasty music, dance, and tomb murals, digital media art prototypes were developed. These prototypes were based on professional dancers' motion capture data, creating an immersive, interactive experience for audiences. Expert feedback was systematically analysed through evaluations and reviews to assess the impact of audience engagement and understanding of Tang music and dance traditions. The results indicate that this method effectively represents Tang Dynasty music and dance performances, thereby increasing audience interaction and cultural awareness. This study highlights the potential of motion capture technology in designing immersive digital media art experiences and suggests its broader implications for cultural heritage preservation and education.

**Keywords:** motion capture technology; digital media art; Tang Dynasty tomb murals; depictions of music and dance; digital restoration.

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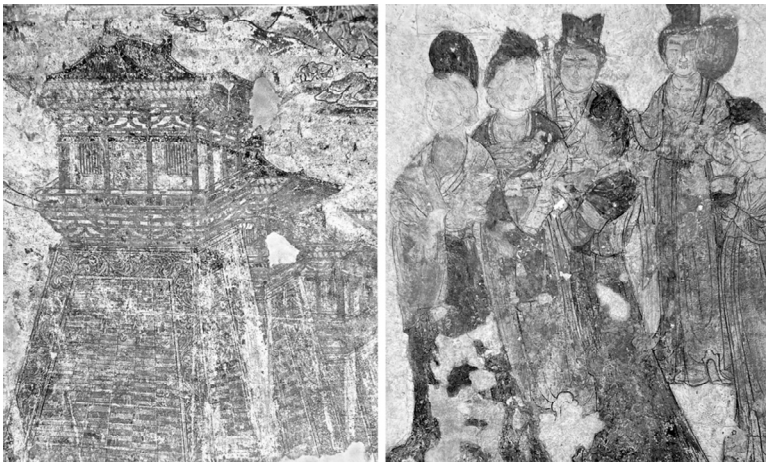
## 1 Introduction

Tang Dynasty tomb murals reflect the aristocratic culture of their era, representing an integral part of mainstream Tang Dynasty culture (Figure 1). These murals vividly record various aspects of Tang Dynasty culture, from laws and regulations to social customs, religious beliefs, and prevalent ideas (Xingming, 2005). However, these tomb murals' physical state and socio-cultural context have significantly altered. Consequently, museum visitors often require assistance comprehending the murals' content and mode of expression (Jie, 2021). Against this backdrop, the current research identifies and addresses the need for an effective method to disseminate knowledge about Tang Dynasty tomb murals and enhance audience understanding.

**Figure 1** The exhibition of murals in the tombs of the Tang Dynasty

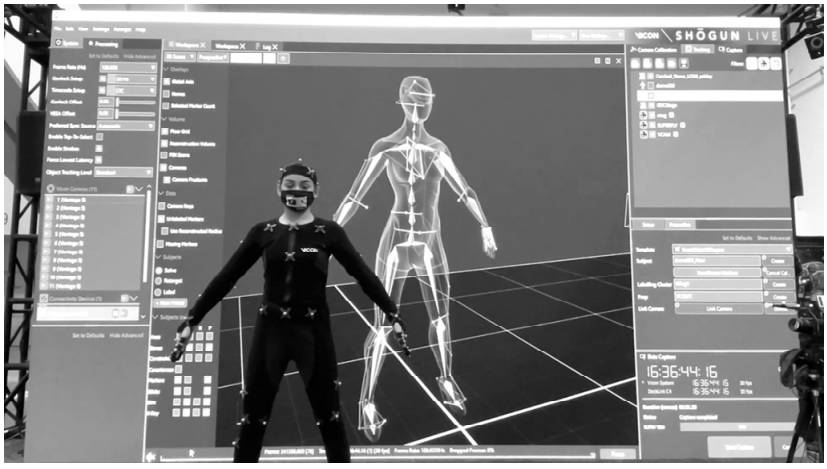


*Source:* Shaanxi History Museum, China

Motion capture technology, which records and captures human posture using external equipment (Nogueira, 2011), offers a potential solution. Originating in biomechanics research in the 1970s and 1980s, motion capture technology has since expanded into various fields, including education, sports, computer animation, television, film, and video games. Motion capture systems typically comprise hardware components like signal transmitting and receiving sensors, acquisition equipment, data processing equipment, and software modules for system settings, space calibration, motion capture,

data processing, and 3D model mapping. Depending on technical principles, motion capture systems can be classified into five categories: mechanical, acoustic, electromagnetic, inertial sensor, and optical, with the latter two commonly used in performance and animation production (Figure 2).

**Figure 2** Live subject calibration with Veronica at the Vicon demo booth at GDC 2022




*Source:* https://mlsentertainment.wordpress.com/2022/05/30/real-time-motion-capture-at-gdc-2022/

Motion capture technology promises to revitalise the music and dance depictions in Tang Dynasty tomb murals via digital media art. Collecting and processing data on dance movements in tomb murals enables digital media art exhibitions to present Tang Dynasty music and dance intuitively. This technology enhances traditional two-dimensional static exhibitions by providing a multi-dimensional, variable viewing distance and immersive visiting experience. Furthermore, integrating motion capture technology into interactive games encourages audience participation and increases engagement with Tang Dynasty music and dance. This research seeks to utilise motion capture technology in designing digital media art based on Tang Dynasty tomb murals, thereby enhancing audience understanding and offering a novel solution for preserving, disseminating, and studying Tang Dynasty dances (JianJun et al., 2022). The subsequent sections discuss the theory of motion capture technology in digital media art, its specific design and application in digitally restoring Han Xiu's tomb murals, and how to effectively use this technology in designing digital media artwork.

## 2 Objectives

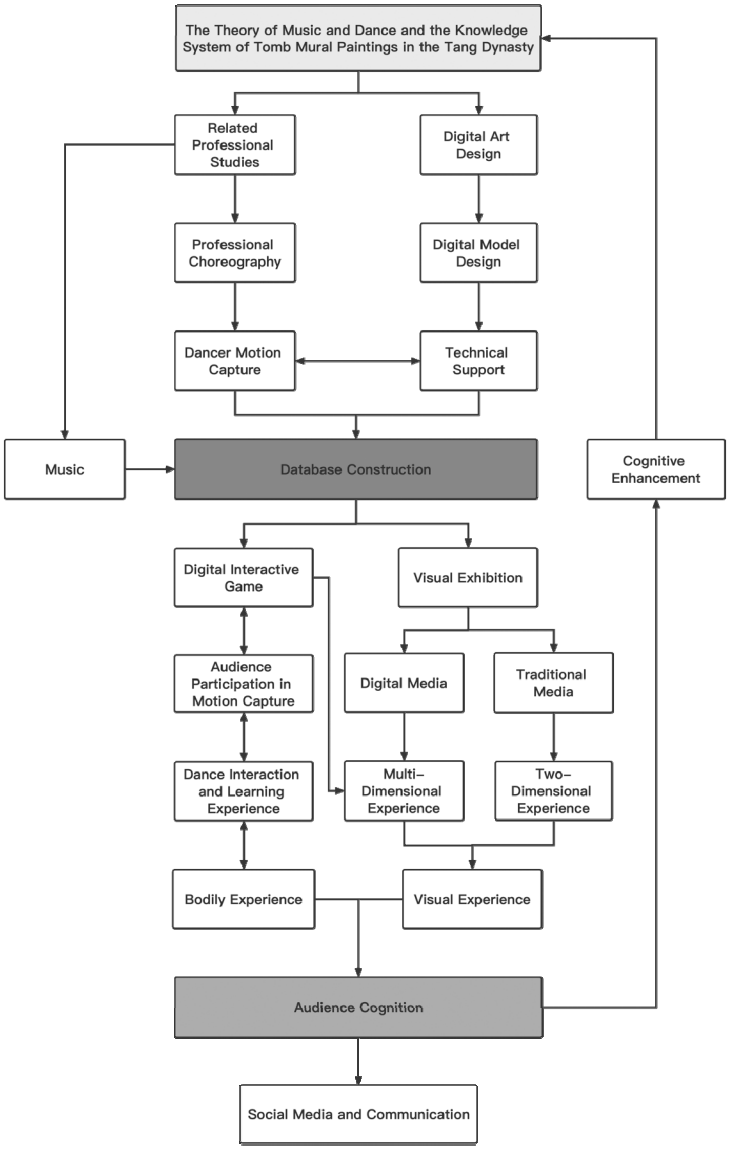
1 To explore the theoretical foundations of motion capture technology within the context of digital media art and understand how it can be applied to digitising cultural heritage.

2 To design and implement motion capture technology to digitally restore the murals in the tomb of Han Xiu from the Tang Dynasty, transforming the static

two-dimensional depiction of dance in the murals into a dynamic multi-dimensional perspective, thereby enhancing the interactive experience of the audience.

3 To validate the effectiveness and value of the research method of restoring Tang Dynasty tomb murals using motion capture technology through expert evaluation and its impact on enhancing audience understanding of Tang Dynasty culture.

**Figure 3** The research framework for recovering tomb murals in the Tang Dynasty by motion capture technology




*Source:* Produced by author

## 3 Framework

The specific process is depicted in Figure 3.

## 4 Research methods

### *4.1 Research scope*

#### *4.1.1 Content scope*

The study concentrates on the music and dance depictions in the tomb murals of Han Xiu's Tomb from the Tang Dynasty. Due to the interdisciplinary nature of the topic, the initial literature review systematically explored music and dance theories of the Tang Dynasty, leveraging insights from musicology and dance studies to define the scope. Subsequently, the research applied digital media art design and motion capture technology to enhance audience engagement and cognition.

#### *4.1.2 Population scope*

The study has secured approval from the Human Research Ethics Committee of Silpakorn University, ensuring full compliance with the Declaration of Helsinki and other applicable ethics, laws, and regulations.

### *4.2 Research tools*

This study primarily sources information from experts in relevant fields. The research tools include audience questionnaires, audio-recording devices, cameras, interview questionnaires, computers, and other equipment suitable for recording images and data.

### *4.3 Data collection*

This study utilises three different methods for data collection:

1 Theoretical data: Information regarding Tang Dynasty tomb murals, music and dance theories of the Tang Dynasty, and literature, textbooks, electronic library databases, and online databases concerning motion capture technology are collected.

2 Expert data: Interviews with domain experts yield qualitative data about applying new media artworks for restoring Tang Dynasty music and dance. The employed research tools include audio-recording devices and cameras.

3 Fieldwork data: Qualitative and quantitative data are gathered by observing the audience and administering surveys. In this case, research tools include audience observation sheets, interview questionnaires, and cameras, which record and collect data on audience behaviour.

## 5 Research and development

### *5.1 Related theories*

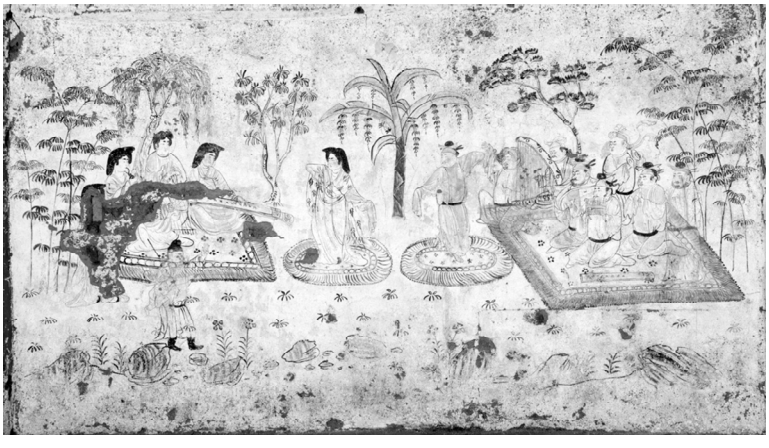
#### *5.1.1 Tang dynasty music and dance theory and music and dance murals in Han Xiu's tomb*

Dance art in China's Tang Dynasty matured significantly following the development of dance techniques in the Han Dynasty and the integration of Chinese and foreign music and dance during the Southern and Northern Dynasties, reaching their peak (Xiaodun and Xiaohui, 2004). The frequent cultural exchanges between China and foreign countries, along with the reliable national power of the Tang Empire and its open and tolerant social thought, contributed to the growth of music and dance in the Tang Dynasty (Wenyan, 2022).

One of the most renowned dances from the Tang Dynasty was Hu Xuanwu, notable for its light, quick, continuous spins. The Tang Dynasty referred to the Hu Xuan dance performed on a circular blanket as a 'dance feast'. The bead pattern on the round carpet, influenced by Persian Sassanian culture, reflects the fusion of Western ritual and music culture in ancient Chang'an City (Shepherd, 1964).

In 2014, archaeologists excavated Hanxiu's tomb, unveiling numerous precious Tang Dynasty tomb murals, most notably the Music and Dance mural on the east wall (Figure 4). The mural depicts 14 people, with female musicians on the left and male musicians on the right, kneeling on a square blanket. A male and female dancer performs the Huxuan dance on a round carpet with a bead pattern (Xu and Xia, 2019). The instruments shown include harps, minor copper cymbals, and Central Plain instruments such as zithers, sheng, and clappers (Chenjie, 2018).

**Figure 4** The exhibition of murals in the tombs of the Tang Dynasty



*Source:* Shaanxi History Museum, China

Researchers suggest that studying Tang Dynasty music and dance theory and the knowledge system of Tang Dynasty tomb murals can provide valuable theoretical support for digital media art development. This knowledge can be applied in digital media

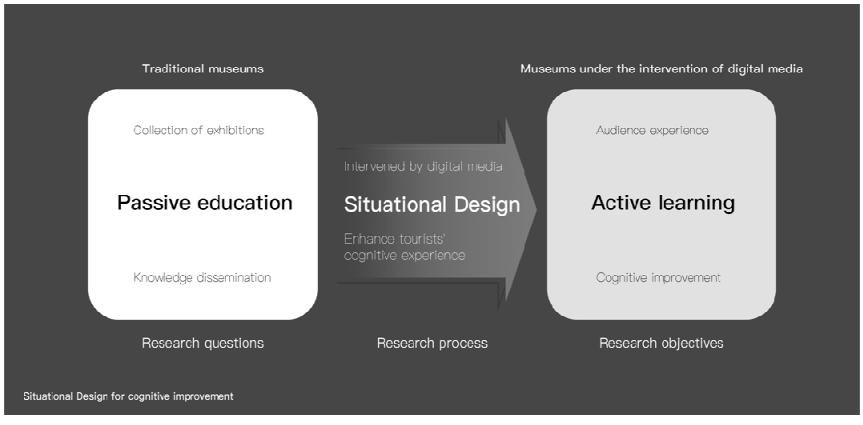
artwork design, mainly using advanced motion capture technology, to create a digital representation of the excellent Huxuan dance performance from the Tang Dynasty.

### *5.1.2 Digital media art intervention in the exhibition of tang dynasty tomb murals: situational design theory*

The situational design of digital media in the exhibition of Tang Dynasty tomb murals aims to highlight the cultural significance and value of the murals. Digital media should serve as more than a technical tool for exhibiting murals. However, they should also explore innovative ways of information dissemination by leveraging digital media technology's unique communication, interactivity, and display capabilities (Yingchong, 2019).

The framework for the digitised situational design emphasises the relationship between the exhibition space, medium, audience, and exhibition form. The research aimed to enhance the audience's awareness by coordinating the influencing factors (Jingbo, 2019). Wen Jingbo's doctoral dissertation provides a method and concept for situation design using digital media, analysing museum experiences and the elements of situation design in the digital age through literature and case studies (Figure 5).

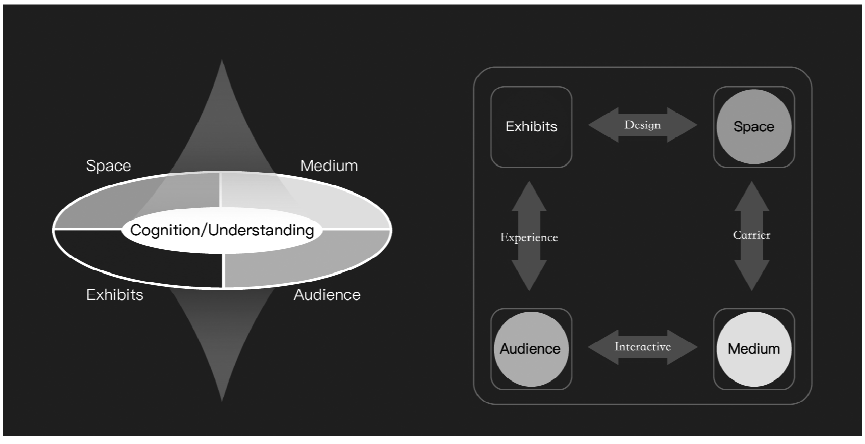
**Figure 5** Situational design for cognitive improvement




*Source:* Produced by author

Dr Guo Jie and Dr Atithep Chaetnala further elaborate on the importance of digital media art in the exhibition of Tang Dynasty tomb murals in their paper (Jie and Chaetnalao, 2022). They discuss the artistic value of the murals, summarise the guiding principles of transforming Tang Dynasty culture from abstract concepts to tangible mural forms, and analyse the current limitations of existing mural exhibition methods. This approach takes audience experience as the core of the digital media situational space design, enhancing the audience's cognition during the visit. Through practice and continuous research, this approach provides an effective method for the digital preservation and exhibition of cultural relics in Chinese museums (Figure 6).

**Figure 6** The relationship between the relevant factors that affect the audience's awareness of museum visits




*Source:* Produced by author

## *5.2 Restoration and development of digital media art based on motion capture technology in Han Xiu's tomb's music and dance murals during the tang dynasty*

### *5.2.1 Analysis of the music and dance depictions in the tomb murals from the tang dynasty to design and explore suitable technical means for digital media art intervention*

Tomb murals, being static paintings, inherently limit the expression of dynamic performances such as dance and music. The music and dance of the Tang Dynasty are known for their full emotional expression, tangible conflict, and robust performance tension (Hongyun, 2004) (Figure 7). Han Xiu's tomb murals capture a snapshot of Hu Xuanwu and his band's performance. However, the static nature of the murals needs to fully express the evolving dynamics of sound and movement during the performance. Viewers are thus required to employ their imaginations to flesh out the visual elements in the murals.

However, digital media art opens up new avenues for showcasing the music and dance depicted in the tomb murals of the Tang Dynasty. Advances in computer technology enable novel display modes, including digital models, VR virtual scenes, and interactive digital designs (Kong and Qiao, 2022). These advancements transform the murals from a traditional two-dimensional static display into a multidimensional and dynamic experience which exceeds spatial limitations. Applying digital media interactive game design in mural exhibitions promotes audience participation and interaction, enhancing their understanding and cognition (Qiuxia, 2012). Therefore, applying digital media art design methods in the music and dance depictions from the Tang Dynasty's tomb murals will stimulate the audience's enthusiasm for active learning and engagement.

**Figure 7** The moment of Tang Dynasty dance performance

*Source:* China Oriental Song and Dance Troupe

### *5.2.2 Application of motion capture technology in the digital media art restoration of Tang Dynasty tomb murals*

The present study combines digital media art with the situational design of Tang Dynasty tomb murals, primarily focusing on two aspects. The first involves digitally recreating the depictions of music and dance. The second explores the application of digital media technology for exhibition purposes.

#### *5.2.2.1 Digital restoration of music and dance depictions in Tang dynasty tomb murals*

This research utilises theories of Tang Dynasty music and dance, along with an understanding of tomb mural systems, to perform an in-depth analysis of music and dance depictions in the tomb murals of the Tang Dynasty. Expanding this knowledge base benefits from the input of experts in dance and music. Interviews were conducted with Professor Cheng Tianjian from the Department of Musicology at the Xi'an Conservatory of Music to gain deeper insights into the depicted dance forms and their meanings. Professor Cheng's work, 'Spring in the Garden', offers an authentic reconstruction of the music and dance scene from the mural in Han Xiu's tomb, thereby resurrecting the magnificence of music and dance during the Tang Dynasty (Xiaojing, 2016). These expert insights enable this study to comprehensively understand the depiction of music and dance in the tomb murals of the Tang Dynasty (Figure 8).

Professor Cheng Tianjian's musical and dance compositions draw inspiration from scenes of music and dance murals found in Han Xiu's tomb, and they leverage historical records of the Tang Dynasty's music and dance. The aim is to recreate performances consistent with the historical context faithfully. The music and dance of the Tang Dynasty, rooted in indigenous music and dance systems, assimilated musical melodies and dance expressions from regions as diverse as contemporary India and Central Asia.

**Figure 8** 'The Spring Scenes in the Garden' by the Xi'an Conservatory of Music

*Source:* Xi'an Conservatory of Music

In his research, Professor Cheng utilised local Chinese literature and broadened his scope to include relevant music and dance literature from India and Central Asia. This comprehensive approach successfully recreated the music and dance performances of the Tang Dynasty as depicted in the murals of Han Xiu's tomb. Although Professor Cheng's research outcomes are presented to the audience via traditional music and dance performances, they establish a robust research foundation for this study's progression. His research provides the essential groundwork for implementing digital technology in this domain, setting a course for future exploration.

The systematic music and dance theories and knowledge systems developed through this research lay a solid foundation for future digital media interventions to restore the music and dance scenes in the tomb murals of the Tang Dynasty. Accordingly, the researchers undertook the digital restoration of these scenes, adopting two strategies – one involved motion capture technology to extract movement data from digital models of professional dancers.

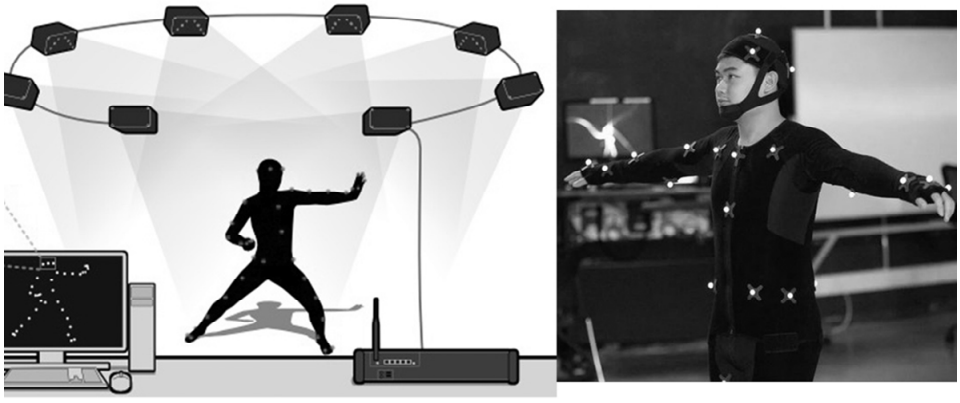
#### *5.2.2.1.1 Extraction of professional dancers' motion data using motion capture technology*

Motion capture technology in digital media enables the capture of a dancer's body language. Technically, motion capture involves measuring, tracking, and recording the trajectory of objects in a three-dimensional space. During dance performances, motion capture equipment must consider physical and spatial constraints imposed by the technology on professional dancers (Hachimura et al., 2004).

In this study, we employed a marker-type optical motion capture device (Figure 9). The optical motion capture system uses computer vision to monitor and track target feature points from various angles via multiple high-speed cameras (Guerra-Filho, 2005). This system includes optical markers, motion capture cameras, transmission equipment, and data processing workstations – marking critical parts of moving objects, such as

human joints. Several motion capture cameras detect these markers simultaneously from various angles.

**Figure 9** Optical motion capture device with markers



*Source:* Produced by author

The data processing workstation receives the transmitted data in real time, and the system, employing the principle of triangulation, accurately calculates the spatial coordinates of the marker points. Based on the principles of biological kinematics, the system computes the skeleton's 6-degree-of-freedom (6DoF) motion data. In physics, engineering, and computer graphics, 6DoF refers to the full range of motion a body can experience in three-dimensional space. It includes tracking and analysing all potential movements and orientations of body joints, such as shoulders or knees. In this research context, the 6DoF capability enables the creation of detailed and accurate digital representations of dancers' movements, contributing to the photorealistic and immersive qualities of the ensuing digital media art.

This system offers several advantages:

- It allows the performer a wide range of movement without the constraints of cables or mechanical devices.
- It boasts a high sampling rate, a high update rate, and low latency, making it suitable for most high-speed motion measurements.
- It allows adding extra markers as needed, thereby facilitating system expansion.
- Once the three-dimensional position information of a marker point is calculated, the motion capture system completes continuous shooting, image storage, analysis, processing of the performer's movements, and real-time recording of movement trajectories.

The data collection process for music and dance performances in the Tang Dynasty is as follows (Figure 10):

a Venue: A 5m x 5m motion capture space was selected for dance movement data collection. The researchers installed eight high-resolution infrared cameras around the perimeter of the space, two on each side, to ensure accurate motion capture. After using a calibration tool, the motion capture software calculated the accurate relative

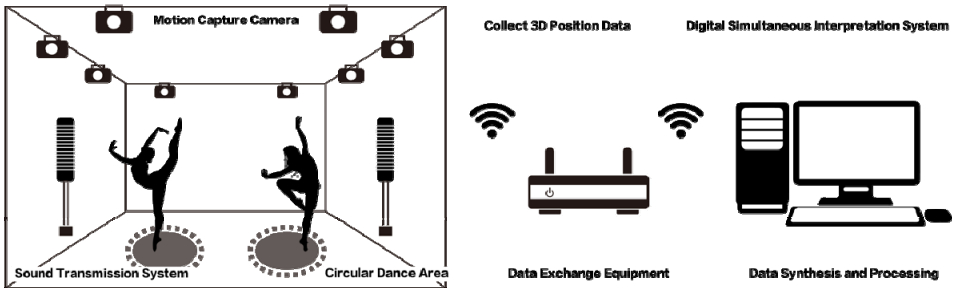
spatial position and angle of the lens, established the X, Y, and Z axes of three-dimensional space coordinates, and prepared for precise motion capture. Two round blankets were placed in the centre of the venue to simulate the scene of the Huxuan dance performance in the Tang Dynasty.

b Dance data collection: The researchers collected dance data by attaching reflective markers to the joints of professional dancers. The system coded each identification point, and the reference template of the target's skeleton model was established and identified (Van der Kruk and Reijne, 2018). Dancers performed dance sequences according to pre-arranged dance programs. As per the researchers' requirements, professional dancers had to complete two dance performances during data collection, a high-aesthetic-value performance and a specific performance (Chan et al., 2010). The high-aesthetic-value and professional dance performance for digital media art exhibitions; the straightforward performance designed for education and audience participation. These two data sets were vital resources for subsequent digital media art pieces.

c Data processing and analysis: The motion capture signals of professional dancers were quickly and accurately transmitted from the signal capture equipment to the computer system for real-time processing. Researchers corrected the data captured by the motion capture system to model 3D digital models (Figure 11). Within the software, the researchers obtained coherent 3D motion data, including the 3D spatial coordinates of the moving target and the 6-DOF motion parameters of human joints, through motion calculation. It led to the generation of 3D skeletal motion data for driving skeletal animation (Xiaodan et al., 2011). The extracted motion data of professional dancers were subsequently used in this study's database construction, providing digital material support for the future display of digital media art.

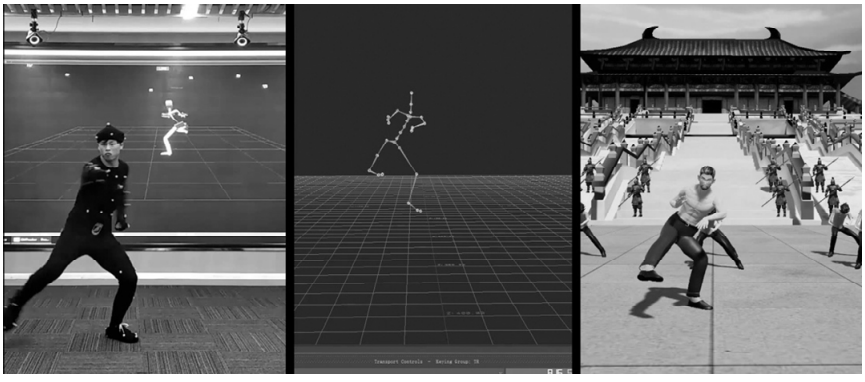
The data on band performances in the Tang Dynasty can also be collected using the abovementioned research. Through the motion capture of band performances, researchers constructed a digital database of band performances in the Tang Dynasty, serving the subsequent development of digital media art.

**Figure 10** Flowchart of capturing dance movements using motion capture technology




*Source:* Produced by author

**Figure 11** Linkage between data acquisition of motion capture technology and 3D digital model



*Source:* Produced by author

#### *5.2.2.1.2 Constructing the visual elements of digital media art through artistic creativity*

The researchers utilised 3D digital modelling to digitally reconstruct visual elements, such as murals and dances, found in the tomb murals of the Tang Dynasty. The intent behind these digital models was to facilitate the display of music and dance scenes from the tomb murals and to innovate visually within digital media art. It was achieved while adhering to the music and dance theory of the Tang Dynasty and the knowledge system of the Tang Dynasty tomb murals. The development of 3D digital models adhered to a six-step production process consisting of concept development, model construction, texture mapping, bone rigging, animation creation, and engine testing (O'Neill, 2008).

**Figure 12** The conceptual setting of the mural scene in the tomb chamber of the Tang Dynasty

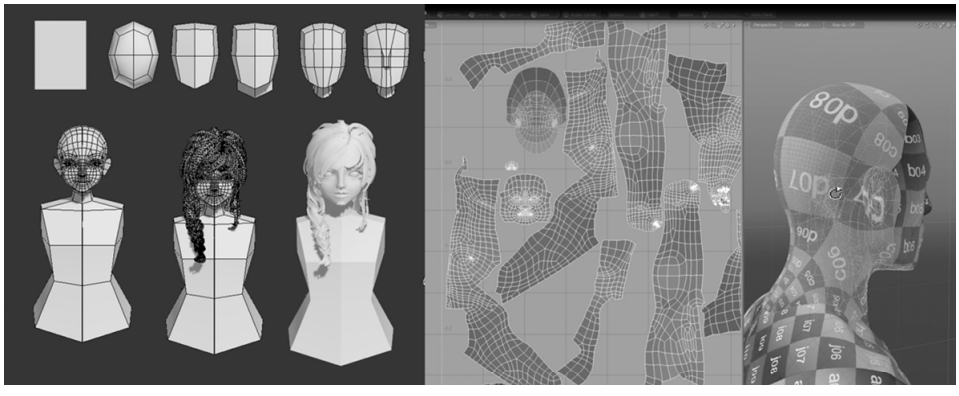
*Source:* Produced by author

The initial concept development stage aimed to establish the visual direction of the overall digital media artwork. Guided by the core principles of this study, the researchers designed an overall artistic proposal for the digital artwork. It included character design, scene setting, and prop selection, which provided a reference standard for subsequent models and unique effect production. Concept development was rooted in the audience's

needs, and a series of works with varying aesthetic styles were designed based on audience preferences. These works served as an interactive platform for visitors to the digital media exhibition of music and dance scenes (Figure 12).

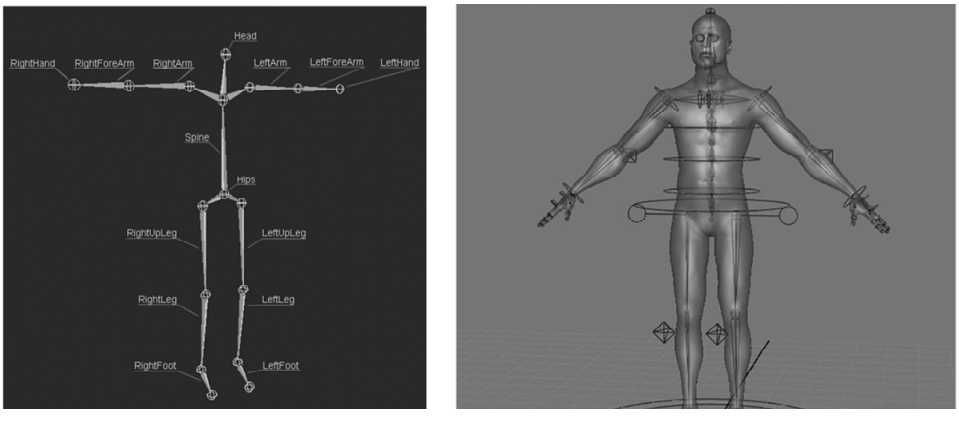
Following the finalisation of the concept, the team proceeded with model construction. The general process is as follows: the team uses 3ds Max software to make medium-quality models; uses Zbrush software to sculpt high-quality models; uses Maya software for retopology to generate low-quality models and perform UV unwrapping; creates models in Marmoset Toolbag software Textures and material maps. Finally, mark the human body data points in the model and perform bone binding and skinning (Figure 13).

**Figure 13** The production process diagram of the 3D model of the character



*Source:* Produced by author

**Figure 14** 3D model and bone binding




*Source:* Produced by author

The researchers complete the modelling and create animations depending on the research objectives. The researchers imported skeletal data into third-party software platforms like Unity, Unreal, Motion Builder, Maya, and 3D Max. The skeletal data was combined with the character models to achieve animation effects (Figure 14). Motion capture data

required refinement with Motionbuilder software before being imported into Maya or 3DMAX for expression or finger animation, ensuring smooth dance movements and musician performances (Andreadis et al., 2010).

The application of motion capture technology and the creative design of visual elements in digital media art enabled the digital restoration of the music and dance scenes found in the Tang Dynasty tomb murals. This digital restoration resolved issues related to the deterioration, lack of clarity, and complex preservation of the original tomb murals. Creating a digital information database can provide technical support and open up numerous possibilities for future digital media art exhibitions.

#### *5.2.2.2 Digital display of music and dance in tang dynasty tomb murals: a multimedia and interactive approach*

This study investigates the digital media display of music and dance depictions in Tang Dynasty tomb murals, focusing on two approaches: multimedia visual display grounded in visual principles and interactive display utilising motion capture technology.

##### *5.2.2.2.1 Multimedia visual display based on visual principles (Figure 15)*

The primary medium of Tang Dynasty tomb murals is painting, a form of visual communication. Given this, our study employed a visually grounded approach to disseminating information, utilising digital media art to reconstruct the original aesthetic of Tang Dynasty tomb murals.

a Two-dimensional visual display of traditional graphic media

By leveraging an existing digital model, we achieved a digital visual restoration of Han Xiu's Tang Dynasty tomb murals. This method effectively addressed preservation, degradation, and unclear original murals while conforming to strict cultural relic preservation requirements. Thus, the composition, colour, and content of Han Xiu's tomb murals in the Tang Dynasty are vividly displayed, providing audiences with intuitive, accurate, and educational visual information (Le Callet and Niebur, 2013). Despite its effectiveness, this approach primarily targets visual information dissemination and needs to fully reconcile the expression of painting and dance, potentially limiting audience comprehension. This method could benefit from a more comprehensive application of digital media art's technical and communication capabilities.

b Two-dimensional visual display of traditional video media

We employed traditional video media to exhibit the music and dance imagery in Han Xiu's tomb murals from the Tang Dynasty. Drawing upon digital resources and guided by Tang Dynasty music and dance theory, we created an animated video demonstrating Tang Dynasty music and dance. This method allowed us to fully explore the value of Tang Dynasty music and dance theory and the digital materials at our disposal. We could faithfully recreate the original performance of Tang Dynasty music and dances for the audience, providing them with an immersive visual and auditory experience. Nonetheless, the audience remains largely passive in this two-dimensional space, suggesting a need for customisation based on viewer preferences and interests.

c Multi-dimensional virtual reality (VR) display of digital media

We employed digital media tools to present a multi-dimensional VR display of Tang Dynasty tomb murals' music and dance imagery. In this study, we applied VR technology to offer audiences a multi-dimensional viewing experience with variable distances (Karnchanapayap and Chaetnalao, 2021). Using Han Xiu's tomb murals as a standard reference, we crafted a three-dimensional virtual space comprising space scenes, characters, and props for audiences to explore music and dance murals. Audiences can actively participate in the entire process of watching music and dance performances via external VR devices, adjusting viewing angles based on their preferences. This method's advantage lies in allowing active audience engagement, transforming the experience from passive information acceptance to active learning and exploration. However, the audience remains an observer during the virtual visit; their experience, rooted in visual and auditory perception, lacks real-time and direct interaction between the display elements. Consequently, this method must meet the audience's somatosensory needs to engage in dance interactions actively.

**Figure 15** Multi-media visual display based on a visual basis

*Source:* Mogao Grottoes Digital Mural Exhibition by Dunhuang Academy

#### *5.2.2.2.2 Motion capture technology-based digital interactive games for interactive display (Figure 16)*

The primary goal of this research is to design digital interactive games utilising motion capture technology to enhance the somatosensory experience of viewers engaging with the digital media art of Tang Dynasty music and dance murals. Recognising the cultural allure of the Tang Dynasty's music and dance and the audience's inclination to participate in dance during their visit, we propose employing motion capture technology to facilitate audience interaction with the digital model.

Our study proposes two motion capture technology options catering to varying audience needs. The first addresses the general needs of the audience, while the second towards those seeking professional knowledge about Tang Dynasty music and dance. The overarching objective is to deliver immersive and interactive experiences tailored to the audience's needs, thus deepening their appreciation of the Tang Dynasty's cultural heritage.

a To cater to the general needs of the audience, we propose using a marker-free optical motion capture system. This system eliminates the need for additional markers on the object, relying instead on joint data derived from 2D images or 3D shape features. The system employs structured light coding projection to garner real-time 3D depth data about objects, discern human pictures, extract joints, and plot general motion trajectories (Tang et al., 2011). Despite its limitations, such as a low frame rate, susceptibility to environmental changes causing motion capture dislocation, and reduced accuracy, the system is low-cost and capable of simultaneously capturing motion from multiple characters. It fits most scenes where active participation in music and dance interactions is anticipated (Okada et al., 2007).

   This technology allows direct interaction between the audience and the digital media art elements. It enhances their multisensory experience from the visual, auditory, and somatosensory movement perspectives, enriching their understanding of music and dance art.

b The research also explores motion capture technology tailored to meet the audience's professional learning needs about Tang Dynasty music and dance. The primary focus here is facilitating dance instruction and posture correction training by capturing the audience's movements for quantitative analysis and studying enhancement methods based on human physiology and physical principles (Ortega and Olmedo, 2017).

The aim is to supplant traditional dance training that is experience-based with a more independent and digital learning approach for Tang Dynasty music and dance. This approach requires a motion capture system with sufficient accuracy and real-time performance. While optical and inertial motion capture systems (mainstream technologies) are deemed suitable for the audience's somatosensory needs, their high cost, complex maintenance, and inconvenience in public environments present notable challenges. The study thus only provides a research idea for future exploration rather than delving deeper into these systems.

**Figure 16** Schematic diagram of the markerless optical motion capture system based on somatosensory interaction

*Source:* Produced by author

In addition to professional learning, motion capture technology has been employed to recreate the digital media art displayed in the Tang Dynasty tomb murals. The aim is to offer audiences a method better to comprehend these murals via a digital media art

exhibit. By integrating traditional multi-modal exhibition communication methods with novel digital media art communication modes, the research showcases myriad opportunities for audiences to engage with the digital media art display of the Tang Dynasty tomb murals. The long-term goal is to promote in-depth, practice-based research that will serve as a model for the digital preservation and exhibition of cultural artefacts in Chinese museums.

### *5.3 Expert interviews*

The researchers interviewed experts in related fields to verify the rationality and professionalism of the research method and process and evaluate the level of motion-captured digital media art creation. Feedback and opinions from experts served as valuable data, and their constructive suggestions significantly enhanced the study.

#### *5.3.1 Archaeology expert*

An interview was conducted with Mr. Cai Changlin, a senior researcher at the Shaanxi History Museum and Deputy Director of the UNESCO Shaanxi Provincial Art Committee. Mr. Cai provided insights into cultural inheritance and transmission. He acknowledged the 'pan-entertainment' phenomenon in Chinese social and cultural communication and its implications for emotional release. He underscored the potential for fostering positive social and cultural transmission through effective cultural management design. He affirmed the value of motion capture technology to stimulate active learning and thinking among audiences. Specifically, he suggested that the technology could be used to create more engaging and interactive museum exhibits, thereby making the cultural heritage of the Tang Dynasty more accessible to the public.

#### *5.3.2 Dance artist*

An interview was conducted with Mr. Hu Hai, a young choreographer of the China Oriental Performing Arts Group. Mr. Hu discussed how Chinese dance integrates historical and contemporary elements of traditional Chinese culture, national and folk characteristics, and diverse cultural aspects. He supported using motion capture technology to recreate digital media art in the Tang Dynasty tomb murals. He noted that such technology could effectively convey the beauty of traditional Chinese dance, thus eliciting artistic and emotional resonance from audiences. He also suggested that the technology could be used to create more accurate and lifelike digital representations of traditional Chinese dance movements.

#### *5.3.3 Art design education expert*

Professor Zhan Qinchuan, Dean of the College of Design and Art at Shaanxi University of Science and Technology was interviewed. He stressed the importance of establishing a synergistic relationship between digital media exhibitions' technical and design aspects while acknowledging the rapid advancement of digital media technology in China. He suggested that the technology could be incorporated into the curriculum to provide students with hands-on experience creating digital media art.

### *5.3.4 New media art expert*

An interview was conducted with Professor Chen Zanwei, a new media art expert at the Guangzhou Academy of Fine Arts. As a member of the Animation and Digital Media Teaching Steering Committee of the Ministry of Education of China and a senior expert member of the China Digital Art Design Professional Committee, he emphasised the significance of technology integration and interdisciplinary collaboration in modern design. He regarded the study's use of digital technology as reasonable, practical, and experimental, with potential for broader application. He also suggested that the technology could be used to create more immersive and interactive digital art experiences.

By engaging with experts in relevant fields, the researchers acquired valuable insights and reaffirmed the educational significance of the study. These expert interviews broadened the research perspective and enhanced its depth.

## 6 Conclusions and discussion

This study underscores the significant role of motion capture technology in digital media art, specifically its application in digitally restoring the tomb murals of Han Xiu from the Tang Dynasty. The construction of the digital information database of the music and dance images of the tomb murals and the presentation of digital media art have effectively deepened the audience's understanding and experience of the historical context and content of the murals.

This study establishes a comprehensive theoretical framework for music and dance images in tomb murals while constructing a digital information database. The researchers utilised motion capture technology to capture dancers' body language. Combined with creating 3D models from motion capture data, a digital information database was created to support future digital media art presentations.

Regarding the presentation of digital media art, the study incorporated conventional video media, multi-dimensional VR displays, and interactive games based on motion capture technology. These presentations delivered visual and auditory information, enabling immersive and personalised experiences through spatial exploration and variable viewing distances. Furthermore, the marker-free optical motion capture system utilised in the interactive display catered to the somatosensory interaction needs of the audience. It offered ideas for teaching dance and providing posture correction training.

In conclusion, the results of this study suggest that digital media art created using motion capture technology can intuitively and multi-dimensionally showcase the dynamic state of music and dance performances to audiences. It increases the likelihood of audience participation and interaction, thereby enhancing their understanding of the content. The study thereby illustrates the pivotal role of motion capture technology in creating compelling digital media art experiences, offering a successful example of the application of this technology in digitally preserving and presenting cultural relics.

## 7 Suggestions

We recommend further expansion and exploration in this particular research area. Future studies might preserve the current focus and gauge knowledge acquisition concerning the subject matter. One possible strategy would be to institute a pre-and post-test system for viewers. This system would first assess the viewer's initial understanding of the content before their interaction with the motion-captured digital media artwork. Then, following the interaction, a post-test would be administered to ascertain the degree of knowledge enhancement, if any.

Beyond the confines of motion capture, future research could also contemplate other burgeoning technologies. As technology evolves rapidly, so should the modalities of delivering digital media art. Potential areas of exploration may include augmented reality (AR) or mixed reality (MR), both of which could provide an even more immersive viewing experience.

In addition, subsequent studies might also consider creating customised interactive experiences. These could be tailored based on varying audience familiarity or expertise with the Tang Dynasty's music and dance. Such an approach might foster a deeper, more meaningful engagement for novices and experts.

By pursuing these suggested lines of enquiry, we are confident that future research can contribute substantially to our understanding of how best to employ digital media and technological advancements. Specifically, this could enhance audience engagement and educational outcomes in cultural heritage preservation.

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