Research On Integrating Motion Capture and Projection Mapping In Performing Arts

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Abstract

In recent years, immersive theater and motion capture technology have gained prominence in live performances and the performing arts. However, their integration into immersive theater remains relatively unexplored. This research explores the fusion of motion capture technology with performance elements to expand the creative possibilities within immersive theater. Drawing inspiration from the classic "Beauty and the Beast" story, our study focuses on the interplay between appearance and inner self, with motion capture enhancing character development. Performers seamlessly transition between virtual characters and objects, creating immersive experiences in non-traditional venues. This innovative approach represents a significant step in utilizing motion capture in immersive theater. Future work may involve refining motion capture technology and exploring unique viewing perspectives. Our study offers valuable insights and inspiration for creators in this evolving field.

Keywords

Immersive Experience, Motion Capture, Projection mapping, Trauma'

Introduction

In recent years, the development of immersive theater spaces has thrived, and incorporating performances into these immersive environments has become one of the preferred modes. Alongside this, the advancement of motion capture technology has unveiled a new domain ripe for development in performance art, utilizing motion capture. However, relatively few examples of performances in immersive theater spaces utilize motion capture technology.

Building on this concept, our 2021 production "Athena" departed from flat image performances, adopting a real-time interactive approach within a Dome immersive space, setting the stage for our current endeavors. In 2023, we were selected for the LABX Young Creators Studio, a part of the LABX Cross Discipline Platform at the National Taichung Theater. This platform aims to provide an innovative support environment for Taiwanese artists. It serves as an incubator for artistic creation and a platform for cross-disciplinary creative research and development, offering opportunities for learning, knowledge resource sharing, and fostering a spirit of innovation and experimentation. Through a mentorship system involving renowned artists from home and abroad, the platform offers professional learning, research, and creative incubation opportunities for artists under 25. Our selection for this project has allowed us to experiment with integrating motion capture in performance, undertaking a new venture in immersive performance spaces at the National Taichung Theater.

Figure 1. 2021 "Athena" performed at Dome

Literature Review

Immersive theater

Immersive theater, an innovative field blending contemporary art with technology, is emerging as a future trend and has increasingly become a focal point of academic and artistic interest in recent years. The development of this field, particularly in terms of technological innovation, continues to push the boundaries of performing arts. The advancements in motion capture technology and virtual reality (VR) have significantly expanded the expressive capabilities of traditional theater, transforming it into a more interactive and multidimensional experience. On the other hand, audience participation and experience are equally crucial in immersive theater spaces. As Spittle [3] notes, the depth and quality of audience engagement directly affect their sense of immersion, becoming a vital indicator of the success of such performances.

Simultaneously, interdisciplinary collaboration plays a pivotal role in creating immersive theater spaces. Li et al. [4] emphasize that the cooperation between artists, technology experts, designers, and psychologists is the cornerstone for

achieving innovation and maximizing audience experience. Furthermore, the impact of immersive theater spaces on cultural and social levels cannot be overlooked. Overall, immersive theater spaces constitute a diverse and dynamically evolving field, combining art, technology, culture, and social elements to provide audiences with a rich and unique experience. Future research may delve deeper into the further development of this field and explore its potential global impacts.

Atypical in form, the expanded realm of immersive performance spaces represents an innovative and unconventional environment for shows and displays, breaking away from the traditional design and layout of theaters and exhibition halls. These spaces blend novel spatial designs, such as non-traditional structures and multi-layered layouts, emphasizing audience interaction and participation, transforming viewers from passive spectators into integral parts of the performance. Technologically, these atypical immersive spaces extensively incorporate advanced technologies like virtual reality, augmented reality, 360-degree imaging, and interactive projections, continually striving to break the boundaries of traditional performing arts and create unique experiences for the audience.

Figure 2. National Taichung Theater 2F Foyer

Motion Capture

The application of motion capture technology in the field of performing arts has garnered significant attention. This technology enables artists and performers to create and present their works in entirely new ways. In theatrical performances, motion capture technology allows performers to capture and reproduce precise movements, thereby achieving higher performance realism and accuracy. The advantage of this technology lies in its ability to capture bodily movements and record facial expressions and sound, adding depth and dimension to the performance.

Furthermore, motion capture technology has ushered in new possibilities for interactive performances. Audiences can use virtual reality (VR) devices to interact with virtual performers and become part of the creative process. This interactivity gives audiences an unprecedented sense of participation, making them integral to the performance.

Motion capture technology is applied beyond traditional theater into film production, video game development, and virtual reality (VR) fields. In film production, it is widely used to create lifelike special effects and animated characters. As Has research [2] demonstrated, video games offer more natural character movements and interactive experiences. Virtual reality allows users to immerse themselves in a virtual world.

In conclusion, motion capture technology has ushered in a new era in the performing arts, offering artists and audiences rich and diverse experiences and interactive opportunities. With ongoing technological advancements, we can anticipate that it will continue to play a pivotal role in performing arts, bringing forth exciting innovations and possibilities.

Research Method

Design of the Content

Inspired by the story of “Beauty and the Beast” from Grimm’s fairy tales, this work delves into the dichotomy of appearance and inner self and the significance of accepting others. The piece reinterprets this story, transforming the Beast and the Princess into the luminous and dark aspects split from the protagonist’s essence. These represent the two selves hidden deep within the protagonist’s psyche, aiming to highlight the darkness within the human soul, comprising suppressed emotions and desires. Through this creative endeavor, the exploration combines virtual imagery, avatars, and live performers’ presence to interpret the characters’ inner conflict and acceptance. Motion capture technology is employed in the performance to enhance the portrayal of character traits and emotions, aiming to create a more immersive and vivid performance. This approach offers a fresh interpretation of the classic fairy tale, aiming to give the audience a new performance experience.

Performers will use motion capture technology to interpret the character and inner world of the Beast through movements and body language. With the application of this technology, performers can not only manipulate the avatar of the Beast but also seamlessly switch to other virtual characters or even objects. They can control everything within the virtual world and interact with it. However, they maintain a unique coexistence, where the internal and external aspects remain distinct yet interdependent. Consequently, the application of motion capture is an indispensable and pivotal technology in this reimagined rendition of “Beauty and the Beast.”

Creative Process

In this creation, the chosen atypical space, measuring approximately 15 meters in height and 15 meters in width, is a fully curved venue located in the front lobby of the Grand Theater of the National Taichung Theater in Taiwan. This venue has previously hosted large-scale light sculpture performances, but its integration with a performance creation is a first. To accurately reflect the detailed movements of the performers in this creation, OptiTrack's optical motion capture equipment was employed on-site. To distinguish the performers from their characters portrayed through light projection effects, we used costumes to make their faces disappear, reducing their presence as motion capture actors rather than performers.

To enable the audience to experience the immersion brought about by the curved space and to allow the performers' movements to instantly influence the space, thus creating an immersive effect through the transformation of the space, this creation deconstructed the script into four distinct performance segments. For each segment, different experimental approaches were taken to blend the script's context with the effects that the space could offer. These approaches are as follows:

Figure 3. Integrating motion capture technology into live performances.

- Scale:
  The script depicts a beast symbolizing trauma, which does not possess the typical attributes of ferocity, high aggression, and wildness of a beast. Instead, it is closer to a withering, broken, and empty image. In this segment, the sense of envelopment is created through the scale of the curved surface and projection. The venue's unique convex and concave surfaces enhance the feeling of being enveloped in an unfillable void. Therefore, we scaled the beast character to its maximum size. As the performer moves, they wave their hands on both sides of the curved surfaces and control their body movements back and forth to create an intensified magnification effect, even exceeding the projection range.

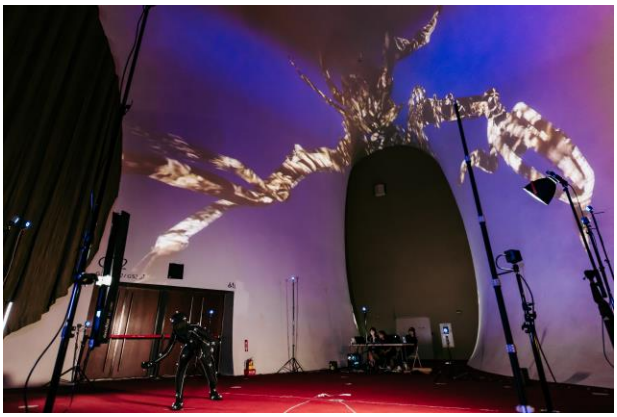

Figure 4. Motion Capture affects the scale of the character.

- Sense of Space:
  We reinterpreted a classic segment from the Beauty and the Beast story. This venue's curved projection surface utilizes the dance's continuous spinning movement. The effect of space is rendered by rotating the camera around the physical coordinates of the performer, combined with the visual impact of the image rotating on the curved surface.

- Lateral Displacement:
  In the script, Beauty and the Beast symbolize self and trauma, respectively, intertwined as one. Thus, in terms of representation, the physical body is alternately dominated by self and trauma. Our visual presentation aimed to convey that the beast and beauty cannot coexist simultaneously and appear interchangeably quickly. The performer only needs to move laterally in the space. Still, the visual effect of the convex and concave surfaces creates a rapid disappearance of one character and the simultaneous appearance of another on a different curved surface.

- Sense of Motion:
  In experiencing trauma, one often goes through several stages, including dissociation. Dissociation is a psychological defense mechanism that separates consciousness activities or memories that can cause psychological pain from overall mental activity, thereby serving to protect the self. In this segment, the character experiences moments of standing still amidst continuous running while the sense of motion in the environment persists. Technically, due to the limitations of the capture range of optical motion capture, we had performers mimic running in place. The software detects the performer's position and movement to generate corresponding visual effects, which supplement the sense of speed in forward and backward movement.

Figure 5. Perform the sense of motion with visual effects.

Conclusion

This performance was staged in the foyer of the Grand Theater at the National Taichung Theatre. Theater experts, performing arts, and new media artists provided guidance during the performance. The experts unanimously affirmed the performance results. They expressed amazement at the attempt to use motion capture technology in an atypical immersive theater setting and hope to see more such innovative endeavors. Regarding suggestions, some experts noted that the simultaneous presence of performers and characters from the script, although differentiated by costumes, still caused some confusion for the audience due to the concurrent use of motion capture technology.

In the future, selecting different motion capture technologies to strengthen the connection between the performance and immersive spaces might mitigate this issue. Additionally, the perspective of viewing in atypical immersive theaters is a topic worth further exploration. This includes whether the viewing mode differs in live performances or how to enhance the necessity of live performance in terms of the manner and orientation of viewing. These are challenges and opportunities not encountered in traditional theaters. This study hopes to provide significant references for creators who wish to explore similar applications in the future.

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Author Biography

A graduate student at the Graduate Institute of Art and Technology, National Tsing Hua University, specializing in interactive design, particularly in augmented reality (AR) and virtual reality (VR) applications. Proficient in 3D technology and game engines, all her works are marked by a distinctive, childlike whimsy and often explore themes centered on parent-child relationships.