



# Research on Dance Education Supported by Virtual Reality Technology

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**Abstract.** This research paper presents an in-depth exploration of the integration of virtual reality (VR) technology within the domain of dance. The study commences with an examination of virtual performance environments, elucidating the methods of shaping a dancer's virtual avatar and the narrative thinking required in the choreographic process. The paper further unveils the architecture of a virtual reality sports dance teaching platform, emphasizing its innovative approach to dance education. The construction of dance three-dimensional models is detailed, employing techniques such as dynamic sampling ray projection algorithms and texture mapping. Human feature extraction is also analyzed, with a focus on the dynamic characteristics of human body posture in dance movements. The paper concludes with case analyses, including a depiction of a dance performance reflecting environmental concerns. The findings of this research contribute to the understanding of the intersection between technology and art, offering new perspectives on dance creation, performance, and education in the digital age.

**Keywords:** Virtual Reality (VR), Dance Choreography, Three-Dimensional Modeling, Human Feature Extraction, Virtual Performance Environment

## 1 Introduction

### 1.1 Background of Dance and Digital Technology

The growing maturity of virtual reality technology offers possibilities for dance creation based on it<sup>[1]</sup>. Simultaneously, against the backdrop of continuously evolving futurist artistic concepts and digital technology, the performing arts field is gestating a digital transformation. Dance, as an integral part of the performing arts, is embracing new technology with a proactive attitude, engaging in a series of experimental explorations<sup>[2]</sup>. The combination of dance and VR technology has become an important manifestation of the trend of integrating dance with technology<sup>[3]</sup>.

## 1.2 Dance Creation Based on Virtual Reality Technology

Among the numerous collaboration projects between virtual reality technology and the performance domain, 'Dancing with the Virtual Dervish,' co-created by choreographer Yacov Sharir, Diane Gromala, and other technicians, initiated an experimental journey of collaboration between dance and virtual reality technology in the 1990s<sup>[4]</sup>. This piece embarked from the perspective of understanding the body through medical means, accomplishing an invasion into and imagination of the real body. It consists of a virtual body formed by the skeleton and internal organs, a body that is constantly in motion, rotating slowly and continuously like the Dervish dancers, never ceasing, as shown in Figure 1. The dancer swims in this virtual body, responding to the relationship between the body, space, and sensation through dance. In Gromala's own words, the "virtual body is an immersive, nonlinear book, a readable text, a habitable building." Through the piece, the director explores many body-related issues, demonstrating the possibilities of collaboration between dance and virtual reality technology<sup>[5]</sup>.



**Fig. 1.** Virtual imagery and dancer's performance in 'Dancing with the Virtual Dervish'

## 1.3 Significance and Purpose of This Study

This paper explores the integration of virtual reality technology within the realm of dance, aiming to innovate and expand the traditional boundaries of dance art and education. Inspired by an encounter with a fish entangled in a plastic bag in the author's daily life, the creation of a solo dance was conceived. By combining dance with virtual technology, both dancers and audience members are allowed to transcend conventional visual and auditory experiences, promoting coordinated innovation between sensory perception and physical movement. The study aims to enhance the authenticity and emotional depth of dance movements through interaction with virtual objects.

## 2 Dance Creation under Virtual Reality Technology

For choreographers, the characteristics of immersion, interaction, and imagination in virtual reality technology provide a more liberated creative realm. Virtual reality is a

scientific and technological field that utilizes computer science and behavioral interfaces to simulate real-time interactive behavior between 3D entities in the virtual world, allowing one or multiple users to immerse themselves in it in a quasi-natural way through sensory motion channels. As a novel technology, virtual reality provides suitable new tools for dance creation and performance.

## **2.1 Creating Virtual Performance Environments**

In traditional dance creation, choreographers focus on the arrangement of movement ontology, while in dance creation using virtual reality technology, attention must be paid not only to the choreography but also to the design of the virtual performance space. Virtual reality technology offers an enclosed, immersive virtual environment for dance creation, constituting an essential part of the visual effects of the entire dance work<sup>[6]</sup>.

## **2.2 Shaping the Dancer's Virtual Avatar**

In dance creation, virtual reality technology can be used to construct a virtual avatar for the dancer<sup>[7]</sup>, which is the visual representation of the real dancer within the virtual space. In April 2020, American rapper Travis Scott hosted a live concert called "Astronomical" in Epic Games' game "Fortnite" using his virtual avatar, causing a tsunami-like sensation. Over 12 million players watched the concert online, and the subsequent videos sparked more than 200 million views. Travis Scott's virtual persona, as an "extension of his own boundaries," was crafted in strict accordance with his actual body proportions and details, down to the specific model of shoes he wears.

# **3 Research on Dance Training Based on Virtual Reality**

## **3.1 Construction of Dance Three-Dimensional Models**

In the process of human body performing sports dance movements: firstly, depth data in a unidirectional aspect of the human body are collected based on the Kinect sensory device<sup>[8]</sup>, transforming the camera origin coordinate system into the world coordinate system to obtain a preliminary reconstructed model; then the dynamic sampling ray projection algorithm is employed for depth reconstruction of the human body's three-dimensional motion model; finally, true modeling of the human body's three-dimensional model is completed based on texture mapping.

### **World Coordinate System Transformation.**

Initially, the collected depth data is processed into three-dimensional vertices from two-dimensional data. Floating-point data is used to replace the original depth frame data, combined with camera coordinate data, to convert floating-point data into point cloud data, aligning with the orientation of the Kinect camera.

### Dynamic Sampling Ray Projection Algorithm.

Traditional ray projection algorithms can be used for depth reconstruction of the initial human body reconstruction results<sup>[9]</sup>. The principle is as follows: Starting from each pixel on the sample image, a ray is emitted in the direction of the viewpoint, which passes through the three-dimensional data field. Along each ray, several equidistant sampling points are chosen at a fixed sampling frequency, and the opacity and color values of the nearest eight data points to that sampling point are interpolated tri-linearly, thus obtaining the opacity and color values of that sampling point.

### 3.2 Human Feature Extraction.

Dance movement features mainly analyze the dynamic characteristics of human body posture in space during dance movements<sup>[10]</sup>, helping learners understand how a certain part of the body changes in dance movements to meet the requirements of the action. This paper divides the human body into a total of 10 parts, expressing information about the human body's shape by describing the relationships between these 10 body parts. As shown in Figure 2.

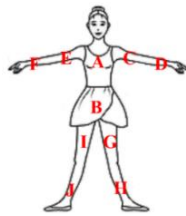


Fig. 2. Components of Dancer's Posture

## 4 Case Analysis

### 4.1 Background Introduction

Figure 3 illustrates a dance performed by the author of this paper, depicting a fish entangled by a plastic bag through virtual reality technology. In this performance, the author mainly portrays a fish caught in plastic debris, reflecting the dancer's profound concern for environmental protection and the issue of plastic waste.

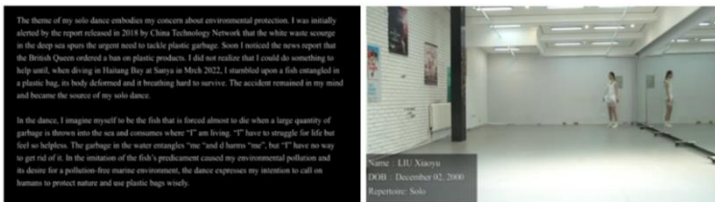


Fig. 3. Representation of a fish entangled by a plastic bag through virtual reality

The first is the process of emotional awakening. The dancer first recognized the seriousness of the plastic waste problem in the 2018 deep-sea white trash report, a realization that was subsequently reinforced by news coverage. This gradually heightened awareness provided an initial motivation for the creation of the solo dance. Secondly, the diving experience in Haitang Bay, Sanya, marked a decisive moment. During this experience, the dancer directly witnessed the devastation that plastic waste inflicted on marine life. This emotionally impactful scene transformed the issue of plastic pollution from abstract to concrete, from distant to immediate. Not only did this strengthen the dancer's sense of mission, but it also provided visual and emotional inspiration for the dance performance. Finally, the solo dance itself, as an artistic instance, successfully connected the dancer's personal experience with the broader theme of environmental protection. By placing oneself in the role of the victimized fish and depicting the injury caused by the underwater debris to "oneself," the dancer transformed a pervasive environmental problem into a human experience that could resonate with others. The dancer's movements, expressions, and stage effects collectively constructed an urgent visual metaphor, revealing not only the severity of the plastic waste issue but also conveying a longing for a pollution-free marine environment.

## 4.2 Integration of Dance and Virtual Reality Applications

### Fusion of Bodily Sensation and Space.

VR technology not only allows the audience to better immerse themselves in the space of the dance but also enhances the dancer's own awareness of bodily sensations. For example, at 2 minutes and 49 seconds into the dance, as the dancer struggles to swim in the ocean of plastic bags, VR technology enables the integration of the dancer's body with the surrounding virtual environment, expressing a more realistic emotional state. This is a special state of spatial fusion that traditional dance cannot offer to the dancer. Figure 4 illustrates the dancer's virtual fish swimming in the ocean.

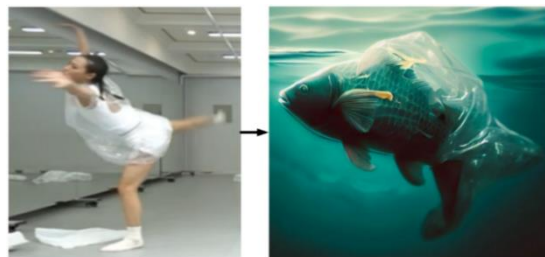


Fig. 4. Expression of Fusion between Dancer's Bodily Sensation and Space

### Emotional Expression in Virtual Environment.

Through VR technology, the dancer can be placed in a virtual marine environment filled with plastic waste. The dancer's struggles and powerlessness, as well as the gradual increase in plastic bags, are all presented to the audience with realistic visual effects,

enabling them to more intuitively feel the impact of plastic waste on the ecology. Figure 5 shows the dancer's struggle and weakness in plastic bags, not only concretized but also imbued with a universal significance.

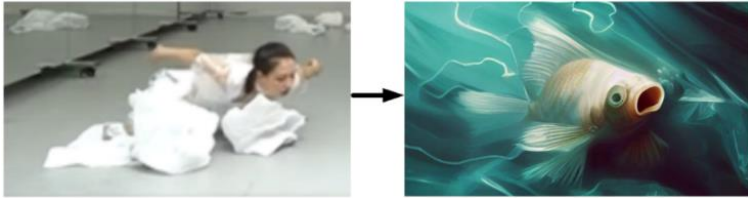
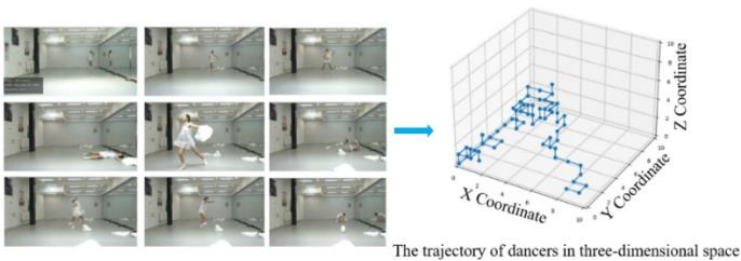


Fig. 5. Dancer's Emotional Expression through Virtual Reality

**Virtual Visualization of Dance Trajectory.**

By using VR technology, we can also visualize the dancer's dance trajectory, which can be used to identify one's shortcomings, or be used in teaching to assist in learning, choreography, and positioning, thereby making better use of space. As shown in Figure 6, the left side of the trajectory diagram expresses the dynamics of motion in space, reflecting the dancer's distribution and movement paths in space in an intuitive way, helping to identify and improve the dancer's spatial utilization deficiencies. The right-side virtual technology visualization further deepens the understanding and analysis of the dance trajectory, providing precise quantitative references for dance choreography and positioning.



The trajectory of dancers in three-dimensional space

Fig. 6. Visualization of Dance Trajectory

**5 Conclusion**

Following an exploration of Virtual Reality (VR) technology in the field of dance, we can draw the following conclusions:

1. Immersive Experience of Environmental Interaction

By constructing a virtual ocean environment filled with plastic waste, VR technology enables both the audience and dancers to more deeply perceive and understand environmental issues. This immersive interactive experience not only

heightens the audience's awareness of environmental protection but also promotes the innovative use of dance as a tool for environmental advocacy.

## 2. Collaborative Innovation of Sensory and Bodily Elements

The application of VR technology in dance transcends traditional visual and auditory experiences, realizing a collaborative innovation between the senses and physical movements. Dancers can not only freely express emotions in the virtual environment but also, through interaction with virtual objects, enhance the realism and emotional depth of dance movements.

## 3. Significance of Subsequent Research

The integration of dance with virtual reality technology signifies the converging trend of art and technology. This interdisciplinary approach provides a new direction and tools for the future exploration of dance art, promoting its advancement. Additionally, the novel application of technology serves an innovative role in advocating for environmental protection.

In summary, through immersive environmental interactions, the coordinated innovation of senses and limbs, as well as the multidimensional expansion of dance education and creation, VR technology not only enriches the depth of dance representation and educational outcomes but also offers new avenues and tools for the future exploration of dance art. The interdisciplinary fusion and innovative practices anticipate further driving the continuous development and innovation of dance art in the intersection of technology and humanities. Furthermore, its pioneering approaches and discoveries provide unparalleled opportunities for the advancement of dance art, education, and promotion, setting a precedent for future endeavors in this interdisciplinary domain.

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