

## *Retraction*

# **Retracted: Scene Construction and Application of Panoramic Virtual Simulation in Interactive Dance Teaching Based on Artificial Intelligence Technology**

### **Journal of Electrical and Computer Engineering**

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

### **References**

- [1] N. Guo and F. Liu, "Scene Construction and Application of Panoramic Virtual Simulation in Interactive Dance Teaching Based on Artificial Intelligence Technology," *Journal of Electrical and Computer Engineering*, vol. 2022, Article ID 5770385, 14 pages, 2022.

## Research Article

# Scene Construction and Application of Panoramic Virtual Simulation in Interactive Dance Teaching Based on Artificial Intelligence Technology

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In recent years, with the rapid development of human motion simulation technology and virtual simulation technology, natural human-computer interaction has become the main form of research in the computer industry. Due to the research capabilities and practical value of mobile video technology, it is widely used in advanced fields, such as video animation production, rehabilitation medicine, sports training, and game software, effectively realizing the connection between the three-dimensional world and the simulation world. However, the application of motion imaging technology in teaching activities is not perfect. This article is based on dance teaching, adopts a dance movement analysis method based on vector matching, and uses artificial intelligence technology to create a virtual panoramic scene. Experimental data show that the average recognition rate of gestures is 89.8%, which can meet the gesture switching interaction of working conditions in virtual simulation of equipment operation.

## 1. Introduction

There are generally two options for learning dance, namely, by self-study (watch the video) or follow the dance teacher. Demonstration training is a simple and affordable way to teach people sports and mental skills. The teacher must first perform dances for the students, and under the guidance of the teacher, the students follow the teacher's movements. Then, the teacher will provide feedback to help students improve their dance skills. This training mode has proven to be effective.

The widespread application of virtual simulation technology in the education field is an inevitable trend in the development of education in the future. The rapid development of virtual simulation technology will inevitably lead the development direction of education reform. Although traditional teaching has the above advantages, it cannot adapt well to the requirements of education and teaching in the information age; the method of relying solely on video teaching has stripped away the vividness of dance teaching

itself and the effect is not satisfactory. The application of virtual simulation technology in the field of dance teaching can solve these problems to a large extent. It combines the teaching methods of the information age with the advantages of traditional dance teaching. It not only maintains the vividness and recentness of teaching but also enables dance teaching itself to break through the limitations of time and space, so that it can better adapt to the development direction of future education.

In the research on artificial intelligence technology and virtual simulation technology, many scholars have conducted research on them and have achieved many good results. For example, Bastug E described the main requirements of wireless Internet VR, selected some key driving factors, and introduced the research approach and its potential major challenges. In addition, he reviewed three VR case studies and provided numerical results under various storage, computing, and network configurations. Finally, he revealed the limitations of the current network and provided reasons for more theories and innovations to

lead the masses in VR [1]. Kihonge J N describes the comprehensive process of designing 4C space mechanisms in a virtual environment. Virtual reality allows users to view and interact with digital models in a more intuitive way than using traditional human-machine interfaces (HCI). The software developed as a part of his research also allows multiple users to network and share design mechanisms. Network tools may greatly enhance the communication between design team members of different industrial sites, thereby reducing design costs [2]. Elbamby MS discussed the challenges and drivers of achieving ultrareliable low-latency VR. In addition, in the case study of an interactive VR game hall, it was demonstrated that the intelligent network design using millimeter wave communication, edge computing, and active caching can realize the future vision of VR [3]. Vankipuram A introduced detailed information about the framework and development methods related to the VR-based advanced cardiac life support training simulator. This is a time-critical, team-based medical scenario. In addition, he also reported the main findings of a usability study. His research aims to evaluate the efficacy of various functions of the VR simulator through post-use questionnaires distributed to various care providers [4]. Jensen K completed the first VATS right upper lobe lobectomy to establish evidence of effectiveness for virtual reality simulator testing. Several simulator indicators indicate a significant difference between novice and experienced surgeons and the pass/fail criteria of the test are set to acceptable results. This test can be used as the first step in evaluating the ability of thoracic surgery trainees to perform VATS lobectomy [5]. Shin D H studied how the motivational revelation in the educational virtual reality (VR) system affects the user experience in order to track and achieve the user's goals. He confirmed the effectiveness and practicality of applying availability to the VR design as a useful concept and proved that the best combination of availability is critical to the success of the VR design [6]. The data of these research results are not perfect, and the experimental results are still to be discussed, so they are not suitable for the general public and cannot be popularized at the same time.

The innovation of this research is mainly connected with dancing teaching through the optical motion capture system, which improves the intuitiveness of learning effect and improves the ability of real-time data collection and analysis. This provides timely feedback for teaching and provides a scientific theoretical support in terms of technology, teaching methods, student acceptance, and innovation. It gets rid of other interference factors of the traditional teaching mode, provides a reliable basis for the improvement of the teaching mode, and helps the system perfect the personalized teaching system. At the same time, the creation of real-time virtual scenes is more in line with today's demand for dance teaching reforms.

## 2. Artificial Intelligence and Virtual Simulation

It has become a trend to filter the external environment with the concept of computer, so that people have more intelligent information and more services. Computer

vision is a simulation of biological vision using computers and related equipment [7]. Its main task is to obtain three-dimensional information of the corresponding scene by processing the collected pictures or videos. According to different objects of computer research, available information, and corresponding motion filtering process, computer vision can be divided into three levels: low, medium, and high [8, 9]. Computer vision classification is shown in Figure 1.

*2.1. Artificial Intelligence Technology.* Artificial intelligence, the English abbreviation is AI. It is a new technological science that studies and develops theories, methods, technologies, and application systems used to simulate, extend, and expand human intelligence. Broadly speaking, artificial intelligence (AI) refers to any behavior of a machine or system that simulates humans. The most basic form of AI is to program computers so that they can "simulate" human behavior based on massive amounts of data collected from similar behaviors in the past [10]. Early AI enabled computers to play games such as checkers with humans, but today's AI has become an indispensable part of daily life [11]. Now, AI solutions can be used not only for quality control, video analysis, voice-to-text conversion (natural language processing), and autonomous driving but also for healthcare, manufacturing, financial services, and entertainment industries [12, 13].

Artificial intelligence is mainly divided into two categories: function-based AI and capability-based AI [14].

Function-based AI is mainly divided into the following categories:

- (1) Responsive machines: this type of AI has no memory and cannot learn from past behaviors, such as IBM's "Deep Blue"
- (2) Limited theory: with the increase of memory, this type of AI can make more informed decisions based on past information, such as common applications such as GPS positioning applications [15]
- (3) Theory of mind: this type of AI is still under development and aims to gain insights into human thinking [16]
- (4) Self-aware AI: this type of AI can understand and evoke human emotions and have their own emotions, and it is still in the hypothetical stage [17].

Ability-based AI is mainly divided into the following categories:

- (1) Dedicated artificial intelligence (ANI): a system that focuses on performing narrow programming tasks. This type of AI is a combination of responsive machines and limited memory, and most of today's AI applications fall into this category [18].
- (2) General artificial intelligence (AGI): this type of AI has the same training, learning, understanding, and execution capabilities as humans [19]. Among them, learning aspects are mainly used in the construction of dance teaching scenes in this research.

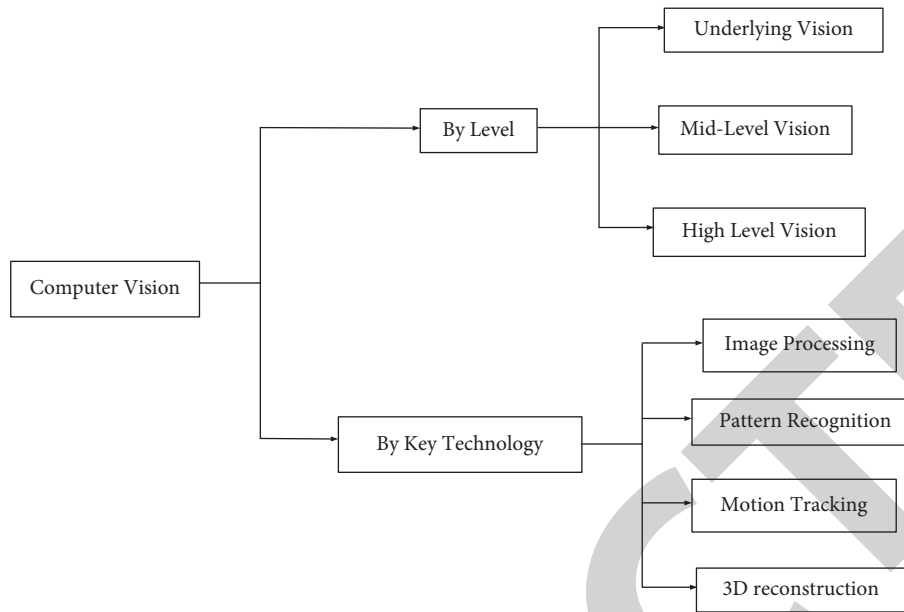


FIGURE 1: Computer vision classification schematic diagram.

- (3) Super artificial intelligence (ASI): this type of AI has excellent data processing, memory, and decision-making capabilities and can complete tasks better than humans. There is no application example yet [20, 21].

AI has the unique ability to extract important insights from data. AI can not only complete tasks that are difficult for humans to conquer on their own but also mine insights from the exponentially increasing mass of data to guide actions and realize value. Today, AI is widely used in various applications in all walks of life, including healthcare, manufacturing, and government affairs. Here are a few specific use cases:

- (1) Standard maintenance and quality control can improve production, manufacturing, and retail through an open IT/OT framework. Such integrated solutions can implement computer vision technology based on enterprise AI to provide optimal maintenance decisions, automate operations, and strengthen quality control processes [22].
- (2) Voice and language processing can transform unstructured audio data into insights and intelligence. It uses technologies such as natural language processing, speech-to-text analysis, biometric search, or real-time call monitoring to allow machines to automatically understand spoken and written language [23].
- (3) Video analysis and monitoring can automatically analyze videos to detect incidents, discover identities, environments, and personnel, and gain operational insights. This scenario uses an edge-to-core video analysis system, which is suitable for various workloads and operating conditions [24].
- (4) Highly autonomous driving is built on the basis of a horizontally expanded data acquisition platform. It

enables developers to build excellent highly automated driving solutions, and this solution is specifically optimized for open source services, machine learning, and deep learning neural networks [25].

**2.2. Interactive Dance Teaching.** Interaction, that is, communication and interaction, is a functional state pursued by many Internet platforms. Through an Internet platform with interactive functions, users can not only obtain relevant information or services on it. It can also enable users to communicate and interact with each other or between users and platforms, so as to collide with more ideas and needs. “Interactive” dance teaching is a framework-based teaching method and under the guidance of the dance teacher, students and teachers jointly develop a teaching plan. It makes full use of available teaching resources and makes resources and different resources interdependent and exchanged. This is also a type of interaction. It is then used by students, and in the feedback evaluation of teachers, so that the use and feedback are mutually guided. It allows students to communicate directly with information and exchanges between teachers and students [26, 27]. The framework of the interactive system is shown in Figure 2.

In the field of communication, interactive teaching is the communication between information disseminators and recipients, so the “interactive” teaching process is the mutual dependence of teaching materials and students themselves. A sociologist once said that “interactive” teaching is a program that differentiates it from current teaching methods. It is likened to the difference between “Bus” and “Taxi”, just like a bus. It was created to meet the needs of the public, but leased out can meet the requirements of some people who want to be emergency or in a hurry. There is no conflict between interactions, as if the pace of learning is fast or slow. This does not depend on the students’ abilities and

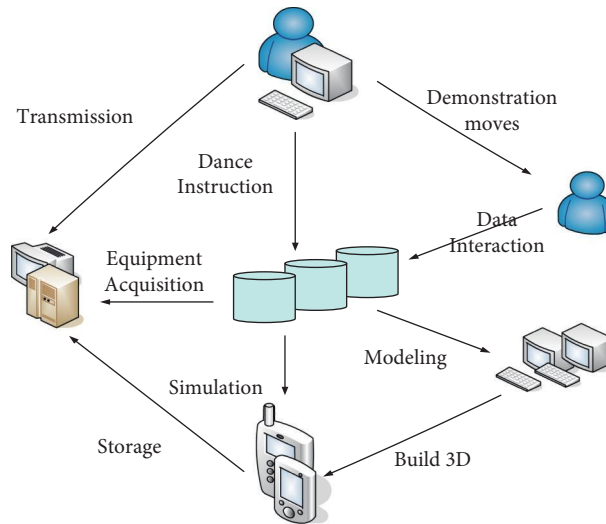


FIGURE 2: Framework of the interactive system.

TABLE 1: Performance parameters of the three gesture interaction devices.

Interaction devices		Leap motion	uSens Fingo	Kinect V2
Color	Resolution	640 * 240	640 * 480	1920 * 1080
	Fps	200	60	30
Depth	Resolution	—	—	512 * 424
	Fps	—	—	30
Joint freedom		26 joints/hands	26 joints/hands	25 joints/person
Testing scope		0.025~0.6 m	0.05~0.7 m	0.5~4.5 m
Angle	Horizontal	(Inverted pyramid)	140°	70°
	Vertical	(Inverted pyramid)	122°	60°
Applicable scenarios	VR/AR	VR/AR	PC	
SDK and recognition stability		Node drifting large	Stable optimization in progress	Bone point stabilization

cannot be entirely a student's problem. The teaching methods of teachers should also be closely linked with the development of students' personality. If the two deviate from each other, then there is no meaning. Interactive teaching can discover and reflect the problems in the teaching process in time. In this way, teachers can find more problems for themselves and students can quickly realize their weaknesses. Then, through the feedback evaluation system, the students make performance again and the teacher gives an evaluation again, so that the students can gradually improve their abilities. In this process, the teachers are very hard, but it is certainly very gratifying to see that the students can completely improve [28].

The interaction of teachers in interactive teaching is mainly reflected in the interaction between teaching resources and teaching staff, the mutual use of different resources themselves, the interaction between students and teachers in the teaching process, and the interaction between students and the teaching environment, and the interaction between education and teachers, teachers and students, students and students, and students and teachers, helping each other and learning from each other. It can get rid of all possible harm competition between individuals. A great responsibility of teachers is to build a suitable platform or stage, so that

students can develop their classmates in the world of education, achieve common progress, and rely on each other to exhaustion [29]. The performance parameter table of the three gesture interaction devices is shown in Table 1.

**2.3. Virtual Simulation and Scene Construction.** Virtual simulation technology mainly includes desktop type, immersive, augmented reality, and distributed technology. Desktop type refers to the establishment of a virtual three-dimensional model in a computer system. It simulates objects in real-life scenes and can be used to construct simulation software, urban planning demonstration platform, etc. The enhanced type is to use virtual registration and fusion technology to superimpose the nonrealistic target into the real scene and display it on the computer. Distributed is to construct a new virtual scene through the computer, such as video chat and so on.

Immersive virtual simulation is the process of obtaining information from the human body through hardware such as gloves and helmets, and then inputting it into the computer to change the state of the virtual environment. This type of enhancement uses virtual recording and aggregation techniques to capture nonvirtual target images in



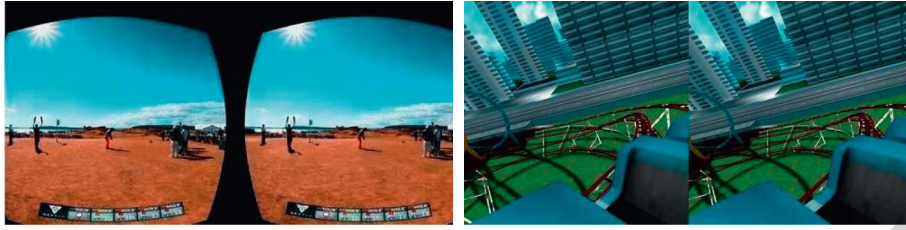


FIGURE 3: Virtual simulation example.

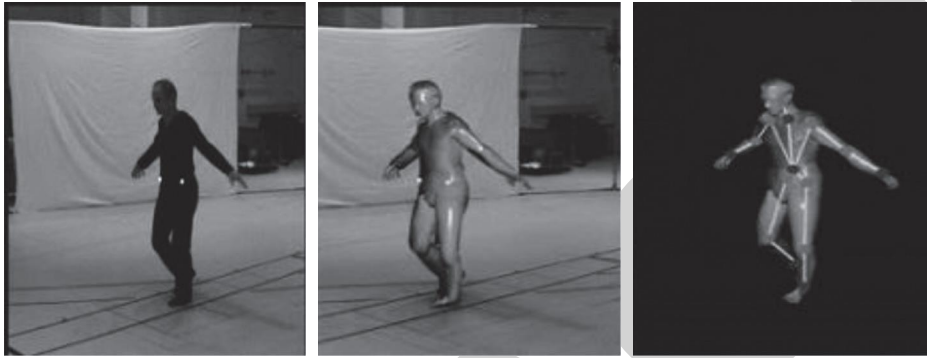


FIGURE 4: Dance motion capture chart.

real time and display them on a computer [30]. An example of virtual simulation is shown in Figure 3.

Motion analysis is one of the main research topics of computer vision. It includes the application of movement analysis in computer vision and dance training, the analysis and classification of student dance movement standards, helping trainers to identify movement abnormalities over time, and the use of descriptive techniques in the analysis. It converts performance indicators into a three-dimensional motion model, establishes a training sample library, and uses test results as a key indicator to measure the level of education, which helps to improve the quality of education. This research combines computer vision motion analysis with dance teaching, studies the characteristics of human motion, and studies analysis techniques. It detects and recognizes motion samples from the video to realize human body analysis. It can scientifically identify positional movement, teaching, and learning goals. High-resolution infrared cameras and sophisticated computer systems provide additional information, such as human limb movement, angle, and joint speed, and provide an effective way to simulate. It aims to learn to dance in a clever way [31, 32]. Figure 4 shows a dance motion capture diagram.

In order to better analyze the movement state of the dance performer, the analysis method of the human body movement posture is realized by using the principle of feature plane similarity matching. This method simplifies the traditional calculation of the Euclidean distance based on multiple identification points to the calculation based on the feature vector of the feature plane and its included angle. In this paper, the identification points of 21 key parts are simplified into 7 feature planes to calculate the difference and correlation of motion [33]. Through verification, this method can quickly and effectively analyze the human body

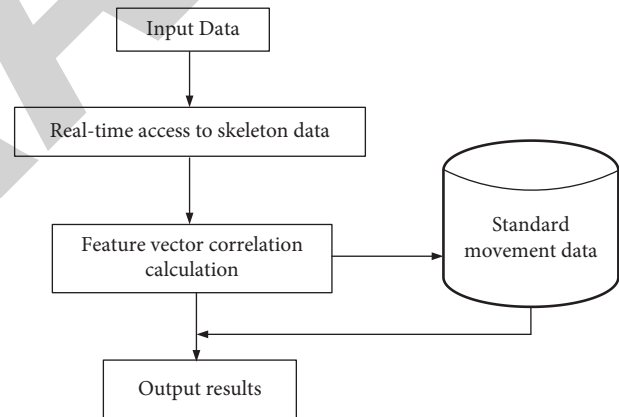


FIGURE 5: Method flow chart.

movement posture and apply it to dance teaching to improve the efficiency of dance teaching. The specific process is shown in Figure 5. The main stages of the analysis process are as follows:

- (1) Real-time acquisition of bone information: it records each stage of the dance performance through optical motion and retains each key point to determine the human body model in the spatial coordinate system
- (2) Body posture analysis: it distinguishes 7 feature planes based on feature points, distinguishes vector attributes and angles of position vectors, and calculates the human body feature coefficients based on the movement characteristics of the main parts of the dance movement
- (3) Character position difference analysis: it analyzes the difference and accuracy of dance movements and

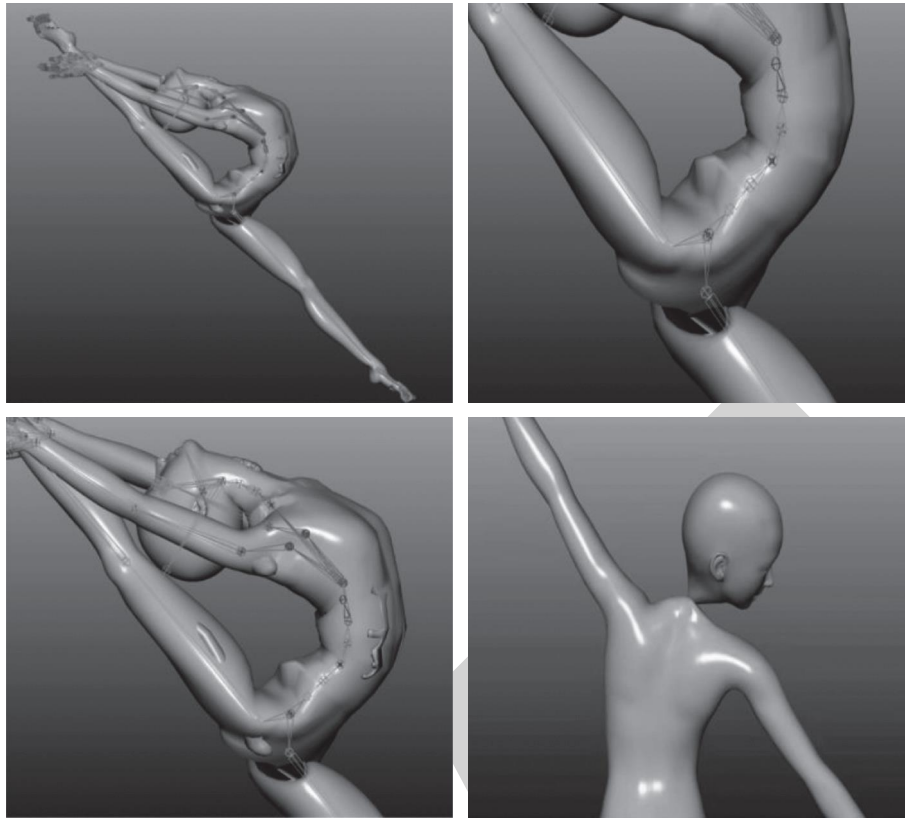


FIGURE 6: Characteristics of the panoramic dance movement modeling method.

students' standard movements through the correlation coefficients of character vectors and their general angles

Dance teaching modeling mainly includes three aspects: human body detection and tracking, somatosensory movement recognition, image-based two-dimensional animation generation and object three-dimensional modeling.

- (1) Human body detection and tracking is the first step of somatosensory recognition, and it is also the basis of scene construction for posture recognition in dance teaching. Human body detection and tracking refers to calibrating the position of the human body through a human body detection and tracking algorithm and tracking the detected human body. It then preprocesses the skeletal data stream of the detected user posture and passes it to the recognition algorithm to complete the somatosensory recognition. Users only need to interact with the system within the visible range of Xbox360 to complete a virtual experience.
- (2) Somatosensory action recognition uses somatosensory recognition technology in dance action recognition, using nested DTW algorithm to process the collected data information. The nested DTW algorithm is a nested DTW algorithm that improves on the traditional DTW algorithm, which reduces the amount of calculation of the matching algorithm and improves the accuracy of action recognition.

- (3) Virtual reality technology is mainly used for 2D animation rendering and 3D modeling, image-based rendering technology generates virtual scenes through some pregenerated images or environment mapping. The animation of the virtual scene is made in collaboration with Photoshop, Maya, and After Effects. Among them, Maya is used for 3D modeling of specific things, Photoshop is used to edit images, texture maps, etc., and After Effects is used to complete video editing. In order to make the two-dimensional background and three-dimensional objects possess more fusion and coordination, this article has done careful processing of the tones, textures, and other elements of the characters and the background.

Features of the panoramic dance movement modeling approach include those as shown in Figure 6.

- (1) Acquiring real-life dance movements and obtaining point cloud data corresponding to these dance movements
- (2) Building a perspective model, said perspective model being a model that superimposes a skeletal model, a ligament model, and a muscle model
- (3) Matching the perspective model with the point cloud data to obtain the dance movement model corresponding to these dance movements
- (4) Generating a dance movement preview based on the dance movement model and making corrections to

TABLE 2: Experimental hardware configuration.

Equipment name	Model	Quantity	Main uses
Six-degree-of-freedom robotic arm	GOOGOL GRB 3016	2	Implementing human-computer interaction tasks
Somatosensory controller	Leap motion	1	Capture user gesture movement information
Somatosensory controller	Microsoft Kinect	1	Capturing robot motion information information
Camera	Double flying swallow	3	Acquisition of experimental images

TABLE 3: Multi-degree-of-freedom robotic arm joint motion range.

Joint	Range of motion	Unit
1	[-170, +170]	deg
2	[-155, +85]	deg
3	[-85, +155]	deg
4	[-180, +180]	deg
5	[-130, +130]	deg
6	[-360, +360]	deg

TABLE 4: D-H parameters of multi-degree-of-freedom robotic arm joints.

Joint	$d$	$\theta$	$a$	$\alpha$
0-1	250	0	150	$-\pi/2$
1-2	0	0	570	$-\pi$
2-3	0	0	150	$\pi/2$
3-4	650	0	0	$-\pi/2$
4-5	0	0	0	$-\pi/2$
5-6	-200	0	0	0

the dance movement model so that the dance movement model conforms to the dance standard

The hardware equipment configuration required for this experiment is shown in Table 2.

Among them, the joint motion range of the six-degree-of-freedom manipulator and the D-H parameters of the joint are shown in Tables 3 and 4, respectively. The motion state of the joint angle of the manipulator is recorded by a decoder installed at each joint, and the user can obtain the motion state of the joint angle of the manipulator through the application programming software interface. Each joint of the robotic arm uses a control board based on an integrated computing unit to control its physical motion commands.

The construction of the virtual dance teaching scene model is a simulation of the dance teaching scene in simulated life and accurately reflects the movements and postures in the dance teaching process. It accurately describes the action guidance process by establishing a realistic three-dimensional model and selecting the correct data processing flow. The main content of virtual three-dimensional model construction is to construct three-dimensional dance teaching visualization and use three-dimensional visualization technology to display three-dimensional lifelike dance teaching data.

The virtual dance teaching scene construction process is shown in Figure 7. Many factors in environmental modeling can be implemented using templates in modeling software. In addition, the principles of environment modeling are also determined based on the environment itself and there is no rigid process.

Most dances contain a lot of repetition, and these repetitive actions do not need to be repetitively learned as shown in Table 5.

The establishment of a three-dimensional model is the key to the success of virtual simulation system software, which is mainly divided into two parts: modeling of virtual characters and modeling of virtual scenes. The most core technology is the modeling of virtual characters. Because the human body is a relatively complex structure, it is very difficult to reproduce the human body in a computer. However, various 3D modeling software has provided many tools for this: for example, the human body model is divided into a skin-skeletal system in 3DS MAX. The famous MAYA software introduces the modeling of muscles and becomes the skin-muscle-skeletal system (this study uses the former: skin-skeletal system). The modeling of environment is relatively simple, mainly involving environment modeling and object modeling. It is shown in Figure 8.

The specific modeling principle and process are more complicated and can be divided into the following steps:

- (1) Geometric modeling. The polygonal surface is mainly used to describe the shape and appearance of the object. The best tool for geometric modeling is three-dimensional modeling software such as 3DS MAX which is mentioned above. It first uses polygons and three-dimensional polyhedral surfaces to describe the appearance of the model and then targets different materials on the surface of the object. It uses different textures to make the object look like an entity with a real surface.
- (2) Motion modeling. It is mainly to model the position and angle of the object, especially for the human body, it is necessary to build a skeletal system, so as to realize the simulation effect of using the skeletal system to control the movement of the surface skin. The skeletal system used in this study is to simplify the real bones of the human body according to the needs. For example, the spine is simplified into three bones, the hand is simplified into a palm bone, and the foot is simplified into a metacarpal bone without further refinement. The specific structure of the skeletal system and the name of each bone can be found in the 3DS MAX human body model file. The name and location of the bones in the human bone model are detailed in the table.
- (3) Skin cover. The human body surface model established in the first step is generally called "skin" because this human body model is just the skin of a character. In the second step, after the skeletal system is established, it is also necessary to modify each bone, the part of the control skin, and the weight of



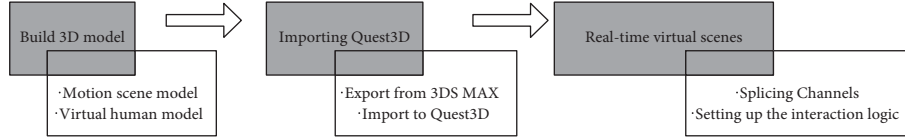


FIGURE 7: Virtual scene construction flow chart.

TABLE 5: Repeat frames in dance.

Dance	Frame rate	Number of frames to be learned	Number of repeated frames (%)
Agogo 1	903	472	431 (47.7%)
Agogo 2	740	480	360 (35.1%)
House 1	2008	1682	326 (16.2%)
House 2	2010	1427	583 (29%)
Hip hop 1	2300	1939	361 (15.7%)
Hip hop 2	2069	1736	333 (16.1%)
Latin 1	2739	1393	1345 (49.1%)
Latin 2	3635	2519	1116 (30.7%)

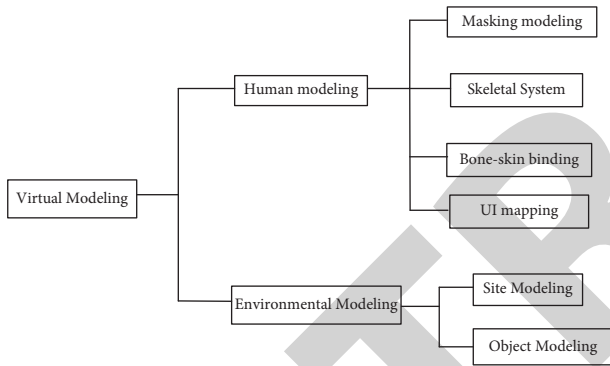


FIGURE 8: Virtual modeling schematic.

the control. This allows the character's skin to be affected by the corresponding bones to move, rotate, squeeze, stretch, and twist when the bones move or rotate. The key point of this step is that when a piece of skin is affected by multiple bones, the weight of the influence of these bones is set. For example, the skin at the junction of the neck and the skull is affected by both the skull and the neck bone. The smoothing of the influence weight needs to be performed here, otherwise the operation of the skin will be unnatural.

The framework of the virtual interaction system for bone and gesture recognition is shown in Figure 9.

### 3. Improved EWMA Algorithm

#### 3.1. Key Technologies of Model Motion Control in Virtual Simulation Scenarios

**3.1.1. Vector.** In the coordinate system, using the three-dimensional Cartesian vector representation:  $V = (V_x, V_y, V_z)$ , then the calculated size is as follows:

$$|V| = \sqrt{V_x^2 + V_y^2 + V_z^2}. \quad (1)$$

Assuming that the vector direction is  $\alpha, \beta, \gamma$ , given by three direction angles, these angles are composed of a coordinate axis and a vector. The direction angle formed by the vector and each coordinate axis is positive, and then the size of these angles is as follows:

$$\cos \alpha = \frac{V_x}{|V|},$$

$$\cos \beta = \frac{V_y}{|V|}, \quad (2)$$

$$\cos \gamma = \frac{V_z}{|V|}.$$

The relationship between the abovementioned three angles is as follows:

$$\cos^2 \alpha + \cos^2 \beta + \cos^2 \gamma = 1. \quad (3)$$

By definition, the sum of two vectors is added by their corresponding components:

$$V_1 + V_2 = (V_{1x} + V_{2x}, V_{1y} + V_{2y}, V_{1z} + V_{2z}). \quad (4)$$

Vector multiplication is divided into a scalar product and a vector product, and the scalar product is also called a dot product.

$$V_1 * V_2 = |V_1| |V_2| \cos \theta, \quad 0 \leq \theta \leq \pi. \quad (5)$$

The formula for the product between two vectors is as follows:

$$V_1 \times V_2 = u |V_1| |V_2| \sin \theta. \quad (6)$$

In (6),  $u$  represents a unit vector that is vertical and two vectors, and  $u$  determines the direction according to the right-hand law.

**3.1.2. Quaternion.** A quaternion refers to a complex number with one real part and three imaginary parts. The specific formula is as follows:

$$q = s + ia + jb + kc. \quad (7)$$

According to the method, the quaternion is issued as follows:

$$q_1 + q_2 = (s_1 + s_2, v_1 + v_2). \quad (8)$$

The formula of quaternion multiplication based on the vector dot product and cross product is as follows:

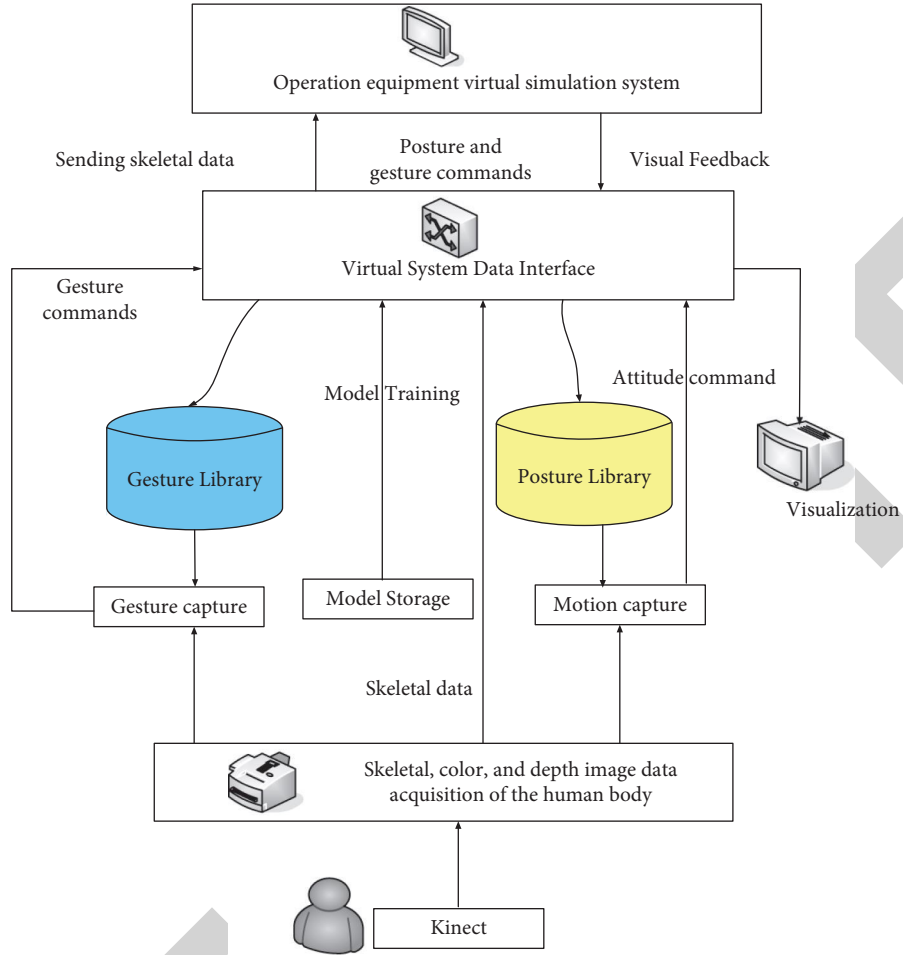


FIGURE 9: Framework of the virtual interaction system with skeleton and gesture recognition.

$$q_1 q_2 = (s_1 s_2 - v_1 * v_2, s_1 v_2 + s_2 v_1 + v_1 \times v_2). \quad (9)$$

The quaternion needs to have the following scalar and vector parts:

$$s = \cos \frac{\theta}{2}, \quad (10)$$

$$v = u \sin \frac{\theta}{2}.$$

Assuming that the coordinates of this point are in the vector part,

$$P' = q P q^{-1}. \quad (11)$$

In the above formula,  $q^{-1} = (s, -v)$  is the conversion of the quaternion number  $q$  composed of the vector part in (10) as a scalar. Namely:  $p' = (0, p')$ , the rotation position point  $p'$  of the sequence, the expression of the cross product and dot product of this point is as follows:

$$p' = s^2 p + v(p \cdot v) + 2s(v \times p) + v \times (v \times p). \quad (12)$$

The  $s$  and  $v$  in (12) are assigned according to (10).

3.2. *Improved EWMA Filtering Algorithm.* The filtering steps of the EWMA algorithm are as follows:

- (1) It records the value of the data by sampling each frame of bone data received by the sensor
- (2) It calculates the parameters of each frame
- (3) It linearly adjusts the calculation result of each frame
- (4) It calculates the output node data along the corresponding line and gives the calculated value of the node data

When the pulse parameter is constant, we check the filtering effect of the standard algorithm and the EWMA algorithm. The test result of the filtering delay effect is shown in Figure 10.

The data show that the input node data have changed significantly in the 50th and 100th frames. The filtering algorithm in this article outputs the actual value of the node data in the 70th and 120th frames, and the standard EWMA algorithm delays the output of the actual value by 8 frames compared with this algorithm.

The comparison of the filtering effect of the standard EWMA algorithm at constant values and the model of weight parameter variation with the adaptive parameter test results are shown in Figure 11.

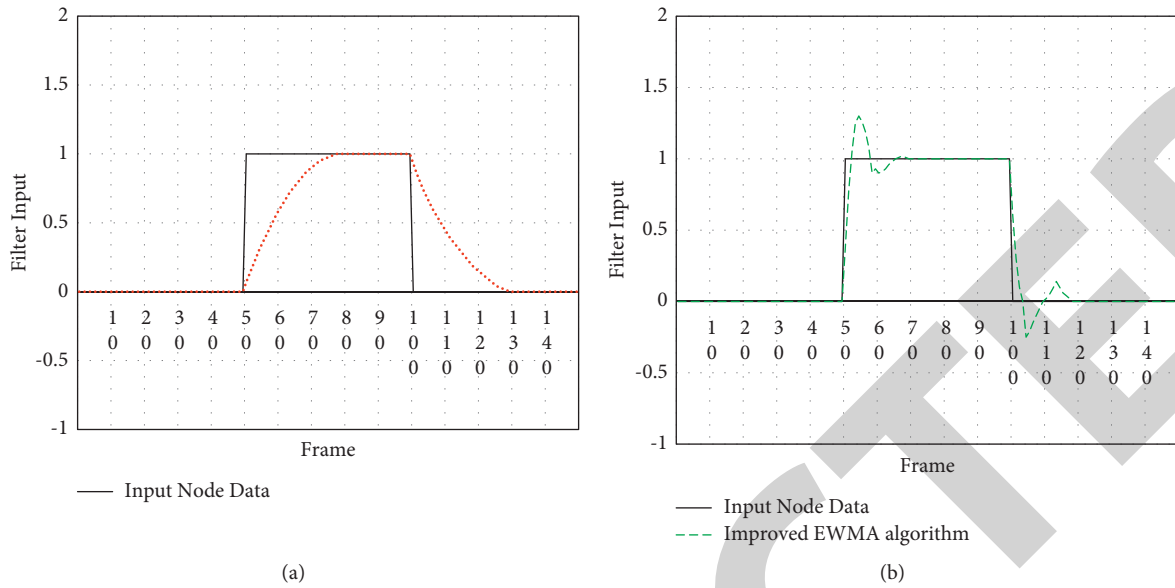


FIGURE 10: Filtering delay effect test results.

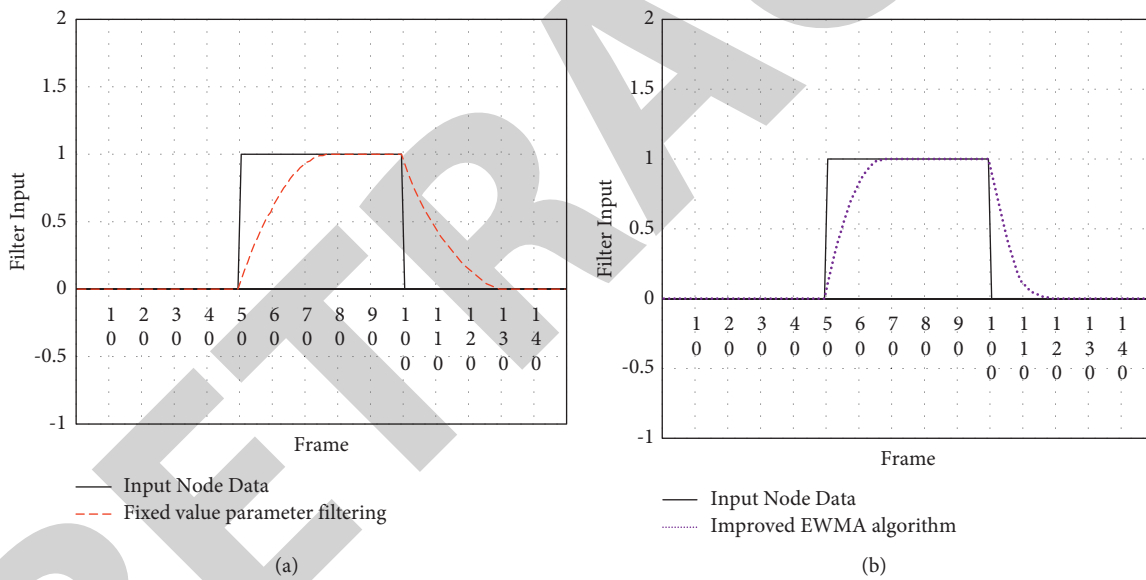


FIGURE 11: Adaptive parameter test.

It can be seen from Figure 11 that the filter algorithm can better adapt to changes in the input node data in the adaptive adjustment mode of the weight parameters. The smoothness of the curve and the delay of the filter in the filtering process are obviously better than the method where the weight parameter is a fixed value.

In this study, the number of test samples for gesture recognition for each gesture was one thousand and the accuracy of the opening gesture and the emergency stop gesture was tested as shown in Figure 12.

It can be seen from Figure 12 that the recognition accuracy rate of the open gesture is 93% and the recognition accuracy rate of the emergency stop gesture is 88%. On the whole, the recognition accuracy has met the standards of

virtual simulation and can be applied to the construction of virtual scenes.

The accuracy rate analysis of recognition classification is mainly to count the correct recognition frequency, wrong classification category, and frequency of continuous real-time test gesture samples as shown in Figure 13.

It can be seen from Figure 13 that the recognition accuracy of gestures in work condition 1 is 85%, the recognition accuracy of gestures in work condition 2 is 90%, and the recognition accuracy of gestures in work condition 3 is 94%. The recognition accuracy rate of gesture 4 in operating condition 4 is 89% and the average recognition rate is 89.8%. This can satisfy the working condition gesture switching interaction of the virtual simulation of equipment operation.

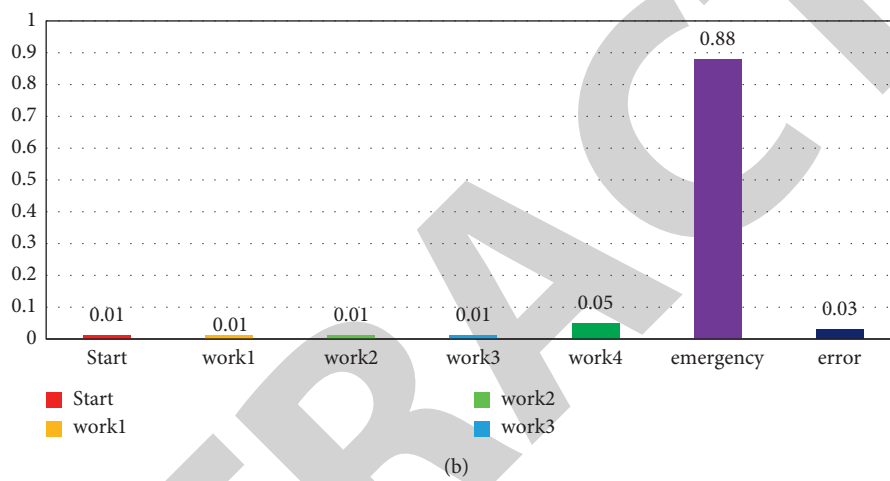
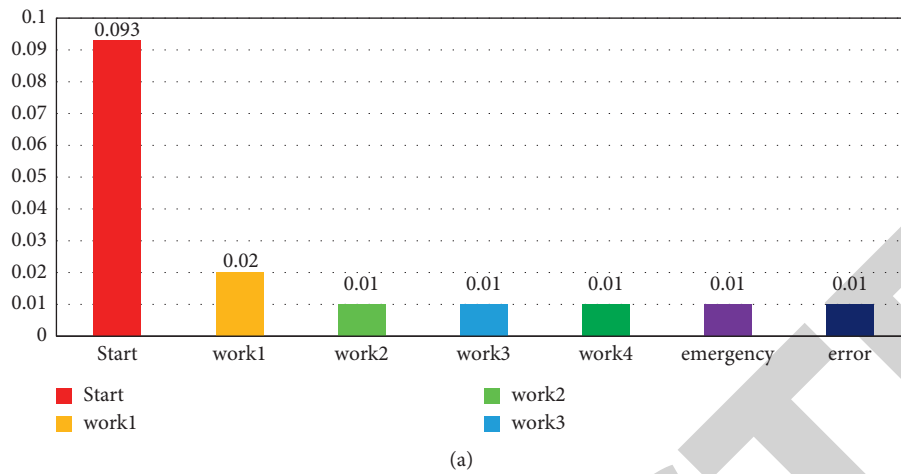


FIGURE 12: Gesture accuracy analysis.

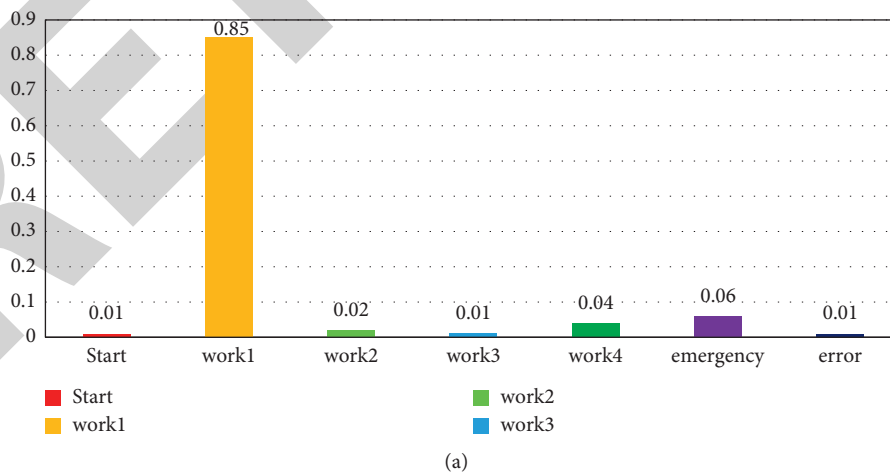


FIGURE 13: Continued.





FIGURE 13: Gesture accuracy analysis.

#### 4. Discussion

“Collecting dance information” is the first step in designing virtual dance scenes based on animation technology. “Data collection” is a basic and indispensable condition in the digital dance process. After collecting the data for the first time, it can be displayed on the next virtual display platform. At present, most dance information collection includes 3 parts: the first is “dance information collection”, which is to

choose digital cameras and advanced digital cameras to collect various dance information; the second is to “realize the digitization of materials” and systematically organize the materials after collecting dance information. In this process, the relevant staff referred to the suggestions of professional dancers and performed dance performances based on the correct use of dance instruments and the final dance materials. It records dance moments through a film system and recognizes digital changes in the dance. The third is to

“create a three-dimensional model.” The 3D design of 3DS MAX combines dance features based on the overall body proportions of most men and women to create consistent costumes.

Because the bones and joints in this article are not detailed to the finger joints of the hand, the expression of gesture interaction depends on the feature training of gesture images and the classification of algorithm models. It is a way of triggering interaction of gesture commands. In order to express hand movements in real time, further research can model the hand joints. It also uses deep learning algorithms to estimate joint parameters and estimate the coordinate positions of finger joint points.

The research and application of this paper are focused on the virtual operation of a single production equipment and a single interactor. In actual production, large and medium-sized factories often do not only operate on a single piece of equipment but also need to consider batch equipment to work together. Therefore, in the future research work, the virtual simulation of the equipment operation process can be considered to increase the transmission and collaborative processing of information between virtual equipment. It improves the efficiency of batch equipment operation and makes equipment operation simulation more conducive to guiding actual production.

At the same time, in the virtual simulation interaction process of the equipment, it is necessary to develop a communication interaction method based on the simultaneous collaborative work of the hands of multiple operators.

## 5. Conclusion

The study uses a dance analysis method based on feature vector adjustment to accurately analyze human movements and provide a theoretical support for dance scientific training. It introduces motion image technology into dance teaching and research and demonstrates dance movements in segments by tracking, capturing, checking, and recording human movements. It solves the problem of repeated presentations by traditional teachers during lectures and gets rid of the interference of students or teachers due to individual differences, psychological, physical, and other factors. Through the effective analysis of computer data, problems are found and corrected in time, which greatly improves the efficiency of education and teaching. The next main research work is to complete the real-time analysis of the human motion posture with the assistance of the optical motion capture system. Judging from the research of this article, the research and development of virtual simulation system for dance teaching in the world is in the ascendant, but it has not attracted enough attention in the field of education technology in China. From a theoretical point of view, the development of the dance teaching virtual simulation system still needs more theoretical research as a support; from a technical point of view, the development of the dance teaching virtual simulation system needs more talents and financial support. In the future, virtual simulation technology will appear in people's lives one after

another. At the same time, this technology will have important significance for some learning and teaching.

## Data Availability

No data were used to support this study.

## Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this article.

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