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Kinematics Method Application and Digital Performance Design of Sinitic Opera

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Abstract. This article proposed a description model of athletic posture for sinitic opera, which contained body structure, spatial orientation and movement force effect three dimensions. A multi rigid model is established based on the relationship between nodes and edges, record the movements of each part with geometric figures to establish the skeleton hierarchy of multiple joint points. In addition, we applied the description method on the virtual human in digital sinitic opera performance system, which is designed based on virtual reality (VR) technique. Also, we extracted the complete set of human motion from sinitic opera such as martial action and choreographic performance in Mei Lanfang faction repertoire, and design the virtual human movements by combining the posture base on the kinematics model above. The results show that this method can effectively realize the digital performance design of sinitic opera and enhance the audience's experience in virtual interactive environment.

Keywords: Kinematics method, Description model, Sinitic opera, Virtual reality.

1. Introduction

Sinitic opera is a traditional performing arts that narrate classical stories through singing and dancing. It has the characteristics of ideographism, and formed a comprehensive art modality through thousands of years on the basis of highly refining daily life and folk performance. Based on the experience of life and rhythmical movement, the body motion in stage performances emphasize the dancing visual appearance under subjective expression of creators, and thus contain rich traditional sinitic aesthetic spirit. Body is an important media for human beings to perceive and connect with the external world. It is through the dance of body that sinitic opera performers convey the connotation of classical culture, including the world view of unity between human and nature, the life view of Confucianism and Taoism, and the values of advocating literature and morality. The creative transformation of sinitic opera in the intelligent media platform emphasizes the body movement shaping of virtual characters. Digital performance as a new art form of online and offline integration conforms to the current communication characteristics and can effectively promote the deep integration of art and technology.

Intelligent media has gradually developed a variety of technical branches and forms after decades of evolution, including but not limited to virtual reality (VR), augmented reality (AR) and physical hybrid reality, which are widely adopted in intelligent connected vehicle cabins, medical assistance systems, military virtual training simulation and digital entertainment systems. The virtual space created by VR can simulate the experience of vision, auditory, tactile sensation and other senses in real world. The virtual human in VR system can realize motion interaction in the scene through real and natural motion, thus providing a technical basis for the sinitic opera aesthetics which contained hands, eyes, trunk and feet. The expressive force of body movement is realized through personal experience and dynamic interactive performance, which further shapes the artistic differences in the high simulation and movement style of the role.

Human motion modeling can be described by the complex system of biomechanics, and has applied to sports training, computer game development, VR simulation and graphics user interface. In this study, the human motion model is established from initial posture and joint motion plane two aspect. First, dance motion posture features are extracted from four dimensions: space, time, gravity and fluency. Then we define the formal description language of motion and establish database of sinitic opera dancing posture. Finally, the model is applied to VR design of Bingxi painting and Mei Lanfang faction repertoire. The proposed model has function of identifying the emotional expression and performance style in sinitic opera dancing posture, laying the foundation for the development of artificial intelligence sinitic opera performance system.

2. Related Works

Human motion model was first proposed in computer graphic animation. Badler [1] constructed Peabody structure in Jack simulation software, which can be used to represent the links that make up human body, and these links are connected by joints. Peabody data structure contains geometric information about link dimension and joint angle. In addition, Peabody can also provide an efficient mechanism to calculate, save and obtain various geometric information.

The most representative musculoskeletal model in open access is the "OpenSim" established by Professor Delp of Stanford University [2]. The Anybody model established by Aalborg University in Denmark has muscle anatomical accuracy of bundle level, and has been applied in spinal column [3] and oral cavity [4] modeling. American Life Modeler Company has been developed the Life MOD plug-in based on the commercial software MSC Adams, which is specially applied to the digital design of artificial joints. The University of British Columbia in Canada has developed the "Arti-Synth" tool for human oral and maxillofacial system [5], introduced large deformation flexible elements into the musculoskeletal model, and realized the coupling simulation of facial [6], tongue [7] and other soft tissues with the musculoskeletal system. At present, the more common bone models are Hill [8] and Zajac [9] models, which include active contraction elements and series and parallel passive stretching elements. There are also studies that regard ligament, cartilage and other bone connection auxiliary structures as hyper-elastic bodies, and use nonlinear spring structures to model [10], so as to achieve the correspondence between dynamic model and anatomical characteristics of the musculoskeletal system [11].

Geometrically exact beam formation (GEBF) can also effectively deal with the coupling problem of large rotation and large deformation of flexible bodies. Renda proposed a geometrically accurate beam model based on Cosset theory, and introduced shear and torsional deformation into the segmented equal curvature model of the soft gripper [12]. Grazioso further verified the prediction accuracy of GEBF on the end displacement of soft robot through experiments [13]. Lie group theory has been initially applied to human dynamics modeling and has achieved valuable results in the field of human posture recognition [14]. Professor Brüls combined GEBF element with Lie group, and disclosed part of its calculation program [15, 16]. Through Lie group modeling principle, it is expected to achieve deep integration of GEBF element and human dynamics modeling.

Lv adopted the inverse dynamics model to process the input kinematics data, and obtains the dynamic motion data close to the real human motion [17]. Dynamic motion data can be further used to generate more realistic and physically interactive virtual human motion [18], it can also be used to build new virtual body motion control methods [19]. He established the multi-body dynamic model of the passive walking robot with knee joint and realized the fast identification of stable gait parameters [20]. Zelei proposed a plane model containing the active moment of the joint and determined the limit cycle satisfying the stable motion process [21]. Nonlinear dynamic analysis is often limited to the simplified human body model with low degrees of freedom, which oversimplifies the skeletal muscle behavior.

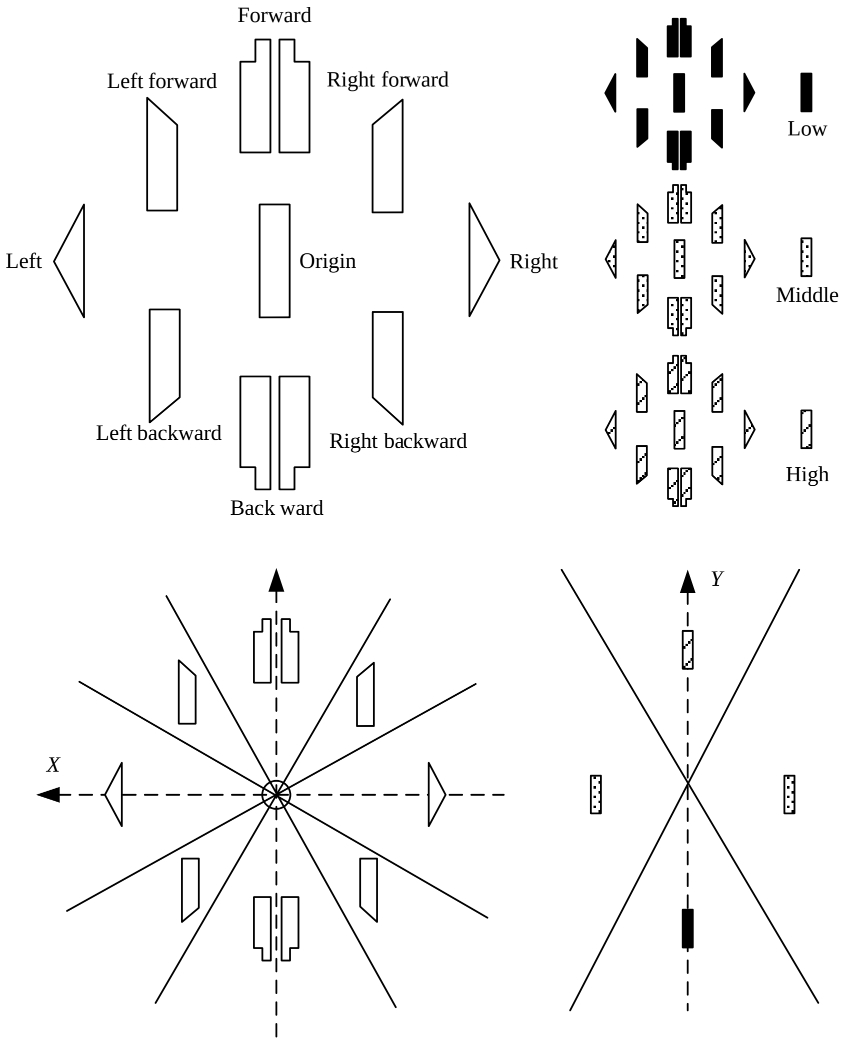

Figure 1. Twenty-seven basic symbols of Labanotation.

Labanotation is the most famous human body description model aiming at the particularity of dance movement. Labanotation is a symbol recording system which was created by Hungarian Rudolf Laban in the early 20th century [22]. The spectrum plane structure of Labanotation is four to eleven columns in the horizontal direction, and each column corresponds to a part of human body. The number of columns can be determined according to creator designed (as shown in Figure 1). The graphical symbol in column indicates that the corresponding body part movement. The vertical length of graphical symbol indicates the duration of movements. Labanotation divides the space into 27 subspaces and each symbol corresponds to a type of movement element. The shape of graphical symbol represents different horizontal directions, and the filling style represents different vertical directions.

Therefore, a sinitic opera dancing posture modeling method is proposed based on combining the classical human motion model and dance description method of Labanotation, which will contribute to the preservation and innovative transformation of traditional performance art in intelligence media.

3. Body Structure Description

The most intuitive method is to build a body motion model for each bone of dancing body, and define the motion constraints between the related bones. Skeleton motion model is used to describe the data structure and relative motion relationship of human joints.

Human body is composed of skeleton, joint and musculoskeletal system, accounting for about 60% of the adult weight. The skeleton of whole body is connected through joints to form a hard human scaffold, which is shaped to support and protect the internal organs. Musculoskeletal is wrapped outside the skeleton, connected with the skeleton through attachment points, and innervated by nerves. Musculoskeletal is the power organ of movement and the power source of body movement [23]. The skeleton plays a leverage role in the movement, and the joint is the hinge of movement. The combined action of the two can maintain the mechanical stability of human body under the external load.

Human motion model requires to abstract the body to some extent, and reflect the real situation as much as possible through simple symbolic description. Since skeleton is a biological composite material composed of collagen and hydroxyapatite, it is simplified as a rigid structure [24]. The rigid structure model mainly includes two parts: joints and segments. The segment is a part with shape and mass, and joint is a part that connects two segments. This model can be regarded as a tree like multi rigid body system consisting of several connected by hinges, so human motion can be described by multi rigid structure dynamic equations. The method of tree human modeling is to first determine the motion of root node of human body, for example, the trunk motion is adopted as the description of the whole human motion, representing the spatial position and direction of the whole human motion, and then determine the tree connection relationship of joints, and determine the parameters of segment and the position of human joints.

The human lower limb is regarded as a rigid body model composed of six rigid bodies. The thigh and lower leg are divided into four rigid bodies according to the knee joint, and the foot forms two rigid bodies according to the ankle joint. Among them, the thighs are connected to the main body, and these six rigid bodies are all connected through ideal rotation joints. This rigid body description method is based on the following assumptions: (1) the mechanical motion of the whole human lower limb is independent of the motion of human trunk; (2) In each joint, bones, muscles and soft tissues are regarded as rigid bodies; (3) The deformation of muscles and soft tissues will not affect the mechanical properties of rigid bodies. The parameters of each rigid body are based on the human data of adults in the national standard GB10000-1988.

4. The Proposed Approach for the Body Motion Model

4.1. Human Body Structure Analysis

Labanotation method is introduced to describe the sinitic opera body motion from the aspects of body structure, spatial orientation and movement force effect. The human body structure is defined as a three-dimensional hierarchy with 27 degrees of freedom (DoF). A multi rigid model is established based on the relative relationship between nodes and edges [25].

Refer to the Labanotation to represent human limbs in the columns, and record the movements of each part with geometric figures. Establish the skeleton hierarchy of multiple joint points, divide the body structure by aggregating similar joint points, and focus on analyzing the orientation changes of limbs and head. The identified human body structure description object divides the body into seven main parts, which are left arm, left leg, left foot, right foot, right leg, right arm and head from left to right. Each column represents a body part.

4.2. Spatial Orientation Analysis

The description method of Labanotation motion space divides the body space orientation of performers. Space vertical orientation is to divide the vertical component according to the height of the gravity center from the ground. The horizontal orientation of space is to divide the human motion space into 8 orientations in each vertical component at an interval of 22.5°.

4.3. Motion Feature Extraction

The rotation angle is converted into position information of the joint node based on Euler angles principle. The joint motion plane should be defined to ensure the integrity of the description. In the initial posture, the direction from one shoulder to the other is the x direction, while the y direction is the body vector pointing upward at the anatomical position, and the z direction is perpendicular to the plane composed of x and y axes. Firstly, the Euler angle is transformed into a matrix, and the rotation angle data is converted into the following matrices:

$$R = R_Z(r) = \begin{bmatrix} \cos r & \sin r & 0 \\ -\sin r & \cos r & 0 \\ 0 & 0 & 1 \end{bmatrix} \tag{1}$$

$$P = P_X(p) = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos p & \sin p \\ 0 & -\sin p & \cos p \end{bmatrix} \tag{2}$$

$$Q = Q_X(q) = \begin{bmatrix} \cos q & 0 & -\sin q \\ 0 & 1 & 0 \\ \sin q & 0 & \cos q \end{bmatrix} \tag{3}$$

where R, P and Q are the rotation matrices of roll angle, pitch angle and yaw angle respectively, rotating around the z, x and y axes, and the rotation angles are r, p and q. According to the properties of the orthogonal matrix, the following rotation matrix N can be obtained:

$$N(RPQ)^{-1} = \begin{bmatrix} \cos r\cos q - \sin r\sin p\sin q & -\sin r\cos p & \cos r\sin q + \sin r\sin p\cos q \\ \sin r\cos q + \cos r\sin p\sin q & \cos r\cos p & \sin r\sin q - \cos r\sin p\cos q \\ -\cos p\sin q & \sin p & \cos p\cos q \end{bmatrix} \tag{4}$$

The rotation matrix calculates the position through the relative orientation between the node and the intermediate node of the root, and obtains the position information in the joint coordinate system through the process of de rotation and de translation. The process of de rotation is as follows:

$$J_0 = N_r \cdot N_{r-1} \cdot N_{r-2} \cdot \cdots \cdot N_2 \cdot N_1 \cdot \begin{bmatrix} x_0 \\ y_0 \\ z_0 \end{bmatrix} \tag{5}$$

where (x_0, y_0, z_0) is the initial offset of the node; N_r, N_{r-1}, N_{r-2}, ..., N_1 represent the rotation matrix of all predecessor nodes from node N to root node.

In the process of de translation, calculate the position offset of each predecessor node of N. The position offset of these nodes relative to their parent node is O_1, ..., O_{r-2}, O_{r-1}, Ot, then the world coordinate of node J_0 is

$$M = O_1 + O_2 + \cdots + O_t \tag{6}$$

Since the movement of human body in space will cause the deviation between the world coordinate of the skeleton node in the x and z directions and the initial acquisition position. The root node coordinate (x_t, y_t, z_t) should be calculated as the relative coordinate of the reference point after obtaining the world coordinate, that is

$$M_0 = M(x, y, z) - M(x_t, y_t, z_t) \tag{7}$$

The characteristic parameters describing human motion biomechanics, such as joint pair distance, skeleton pair angle, human orientation, spatial orientation, and weight and fluency in force effect, are calculated.

Joint pair distance and skeleton pair angle are considered from the perspective of limb structure. The distance v of joint pairs reflects the speed of motion. The distance between joint pairs is calculated by European distance, and its characteristic equation is expressed as equation (8). Skeleton pair angle θ represents the bending state between adjacent bones, and its characteristic equation is equation (9), namely

$$\upsilon = \sqrt{(x_j - x_{j-1})^2 + (y_j - y_{j-1})^2 + (z_j - z_{j-1})^2} \tag{8}$$

$$\partial = \arccos(\upsilon_a \cdot \upsilon_b / (\|\upsilon_a\| \times \|\upsilon_b\|)) \tag{9}$$

where the coordinates of joint point j are (x_j, y_j, z_j), and υ_a and υ_b respectively represent the distances between joint points a and b.

The eigenvalues human orientation, spatial orientation, and the weight and fluency of force effect are considered from the perspective of spatial orientation, and the human orientation n can be expressed as

$$n = \overrightarrow{sl} \times \overrightarrow{sk} = (\beta_1, \beta_2, \beta_3) \tag{10}$$

where l and k are plane normal vectors composed of different bone points respectively.

The spatial orientation s is divided into vertical and horizontal orientation. The vertical orientation divides human skeleton into upper, middle and lower layers. The horizontal component is divided into {front, front left, left, left, right, back, rear right, front right, and original position}, and each horizontal component is divided at an interval of 22.5 °.

Eigenvalue force effect F includes weight and fluency. The weight ω represents the integral of the y-axis coordinate value curve of the joint point to starting and ending points of the time. This parameter represents rise and fall of the motion. Its characteristic equation is

$$\omega = \int_s^e f(y)\mathrm{d}t \tag{11}$$

where the smoothness f represents the expansion and contraction of space through distance, and its characteristic equation is

$$f = 2u(u - d_{12})(u - d_{13})(u - d_{23}) / d_{23} \tag{12}$$

where d_{ij} represents the distance between joint points.

$$u = d_{12} + d_{13} + d_{23} \tag{13}$$

5. Motion description and model application

The dance movement of sinitic opera is structured from three aspects of human body structure, motion orientation and action force effect. The body posture is described by the continuity and periodicity of dance action data. The dance movement is designed succinctly and described intuitively with a three-dimensional human skeleton hierarchical structure, and is applied to the virtual human control of Digital Bingxi, Virtual Mei and Kun Dance Interactive Space.

5.1. Martial Art in Digital Bingxi

Bingxi painting (Zhang Weibang, Yao Wenhan) depicts the grand scene of figure skating which created in the Qianlong period of the Qing Dynasty. Digital Bingxi (Xu Hui, Bai Chenzong, 2022) takes the Bingxi painting as original material, and extracts representative characters for 3D visual design. According to the creation background of Bingxi and the characteristics of the characters, the sinitic opera performance techniques are fully split and applied to the motion of virtual human in Bingxi. The dance avatar actions of the virtual human can convey the style of the sports scenes. Then, after scene acquisition, image recognition, 3D registration, virtual synthesis, human-computer interaction interface and synthesis output and other technical modules, the scene of Bingxi movement was restored through virtual reality fusion in AR media, and providing a new exhibition space for the living display of characters in ancient paintings.

Figure 2. The part of Bingxi Painting.

The Bingxi Painting is collected in Beijing palace museum, vividly depicts the grand scene of Emperor Qianlong's visit to ice playing. "Bingxi" originated from the production and life of ethnic minorities in northern

China in alpine regions, and then gradually changed from production and labor to entertainment. After the Manchu people became masters of the Central Plains, "ice play" gradually merged with the Han culture. During the Qianlong and Jiaqing period, a series of ice projects were carried out in Taiye Pool (now Beihai, Zhonghai and Nanhai). More than 1600 people recruited from army forces and nobles participate in the Bingxi every year, which is a concentrated expression of Chinese traditional sports culture and national body aesthetics (as shown in Figure 2). The Qing Dynasty was the heyday of development of sinitic opera in the capital area, which represented by Peking Opera and Kun Opera. The dancing movements are still alive today, which created by professional artists for generations in sinitic opera. The nationalized body aesthetics and performance resources of contemporary sinitic opera are an effective carrier for the activation and utilization of intangible cultural heritage, providing an appropriate reference for the return and reproduction of virtual body in Digital Bingxi.

Figure 3. Virtual character in Digital Bingxi (Bai Chenzong, Xu Hui, 2022).

First, we selected four bare handed performances and six characters using props from original Bingxi painting and adopted Autodesk Maya 2015 for virtual human modeling (as shown in Figure 3). Second, we used the cube, sphere, humanoid and other primitives in the software to establish the required skeleton. Third, add subdivision surfaces in the model mode, further refine the modeling objects through control points, lines, and surfaces, create deformers during this process to bend, expand, taper and other deformation processes on the required objects to modify the figure shape. Finally, applied the proposed motion model above on the virtual body movement congruence with sinitic opera performance.

Extracted the complete set of martial arts actions from sinitic opera such as Tiao Huache, Jie Dongfeng and Ye Ben, and design the virtual human by combining the posture of trunk and limbs. Body movement bound with the virtual human skeleton such as Jump, gambol, turn over and somersault were selected to reconstruct, transformed and exaggerated. Compared with sinitic opera percussion formula such as [big gong Choutou], [small gong Changsitou], [big gong Yiji], [Ba Da Cang], and [Phoenix three nods] to endow with a sense of speed and strength to the Digital Bingxi.

5.2. Dance of Virtual Mei Lanfang

Mei Lanfang is the most famous actress in the history of sinitic opera who plays female roles. He can not only perform Beijing Opera, but also is expert in rendering Kunqu Opera. The Mei Lanfang faction repertoire created by him is formed through the recreation of art on the basis of inheriting performance of previous artists. The Mei Lanfang, Stanislavsky and Brecht are known as the three major drama systems in the world, which pioneered the dance based sinitic opera performance, and is a major division of the sinitic opera art form around 1950s. This kind of sinitic opera dance not only includes pure and independent body performance, but also includes the dance movements drawing support from props. "Mei Dance" was adopted to summarize the dance of Mei Lanfang intensively in previous researches.

The digital performance system created by AR is based on image technology such as depth image processing, human motion recognition and 3D modeling, which integrates multi-sensor and audio-video acquisition module. Virtual Mei (Gao Tian, Du Siyuan, Zhang Chenwen, Yan Yijin, 2021) aims to show the Mei dance, and restores Mei Lanfang's collection of stage performance in AR system. The display characteristics of AR can break the barriers of physical space and build interactive performances of virtual images with audience in the homospace-time. The body movements of Mei dance were extracted from Beijing Opera Bawang Bieji (Farewell my concubine), Guifei Zuijiu (Drunken Imperial Concubine) and Kunqu Opera Mudan Ting (The Peony Pavilion), and the body movements of virtual human are designed in 3D vision (as shown in Figure 4).

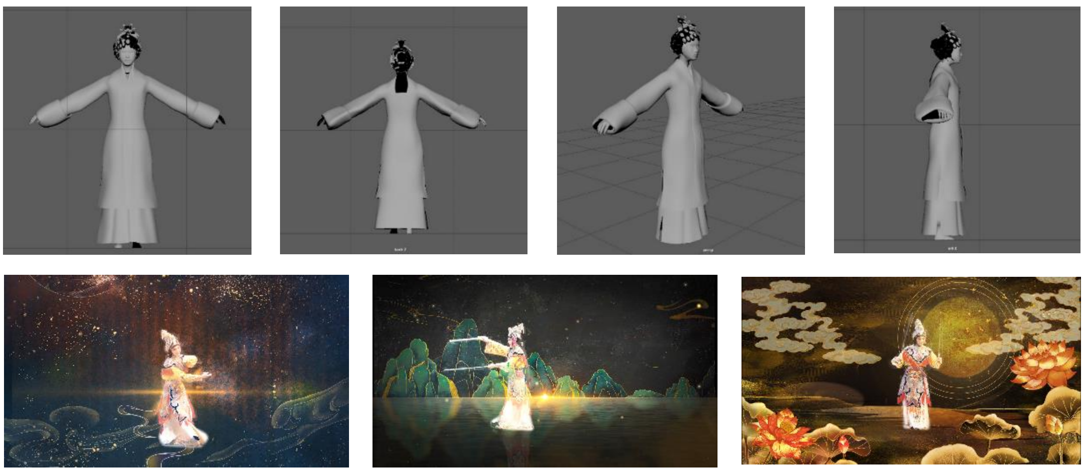

Figure 4. Dance design in Virtual Mei (Du Siyuan, Gao Tian, 2022).

6. Effects of Virtual Reality Immersion on User Behavior

6.1. Preparation in advance

The purpose of this experiment is to evaluate the physiological reaction and visual experience of subjects wearing VR glasses when watching videos. A total of 12 healthy adults aged 19-23 were recruited to participate in the experiment, including 6 males and 6 females. Before the experiment, all 12 subjects were screened and evaluated for their health status, and confirmed that they had no obvious visual, auditory, psychological and nervous system diseases or other serious diseases, and did not exercise vigorously for two hours before entering the laboratory. During the experiment, all subjects showed good willingness and cooperation and completed all the experimental tasks.

After the subjects wore VR glasses to watch the video, they recorded various physiological reactions and subjective evaluation of the visual experience and used 7-Likert scale to coordinate the data and draw a conclusion (as shown in Table 1).

Table1. User experience of sinitic opera in VR equipment.

Category	Index		Mark	Average score
physiological reaction	Nausea symptoms	Increased saliva secretion, sweating	A1	2.25
		regurgitate		2.67
	Orientation disorder	sense of direction	A2	4.83
		Sense of balance		4.58
	Eye discomfort	Difficulty focusing	A3	2.33
		Eye fatigue and dryness		1.67
		Blurred vision		3.41
		Impaired binocular coordination		1.75
	emotional disturbance	Positive emotion (positive) Happy, positive, excited, interesting, etc.	A4	4.33
		Negative emotions (negative) Boredom, sadness, disgust, fear, etc.		2.58
	Relative motion illusion	Physical coordination and balance are we	A5	2.08
		Motion perception is illusory.		6.16
Visual experience	Image clarity (scene, object)		B1	6.08
	Sense of object distance		B2	4.75
	depth of field			5.42
	Color saturation		B3	4.83
	Color contrast			4.17
	Audio-visual synchronization		B4	5.42
	Picture stability			6.16

6.2. Physiological Reaction

Most of participants showed a significant increase in saliva secretion after watching VR videos, indicating that VR content caused a certain degree of physiological stress or excitement (as shown in Figure 4). Additionally, an increase in sweating indicates that participants experience tension, anxiety, or physical discomfort. Nausea may be caused by motion sickness caused by VR or a mismatch between visual and inner ear sensation.

After removing VR glasses, the directional positioning ability of participants deteriorates, which may be due to prolonged exposure to virtual environments leading to a decrease in their ability to adapt to the real world. The weakened balance ability indicates that the VR experience affects the parts of the inner ear or brain responsible for balance, resulting in temporary instability.

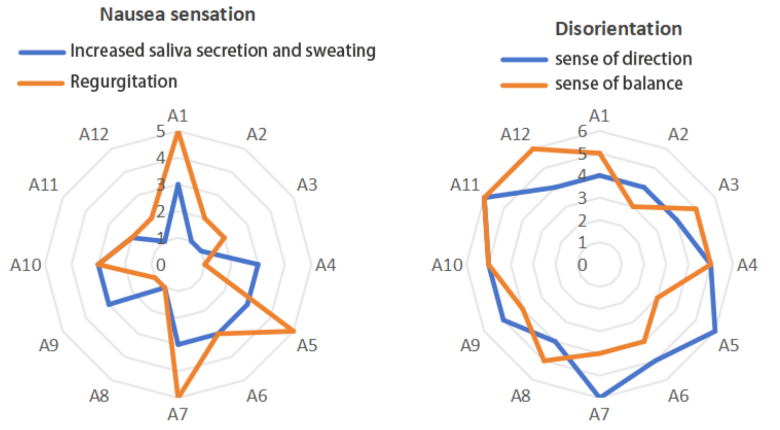

Figure 4. Physiological response.

The subjects who watched VR videos had obvious physiological experiences such as difficulty focusing, eye fatigue and dryness, blurred vision, etc., indicating that VR content was too complex, leading to visual fatigue. Eye fatigue and dryness may be caused by prolonged staring at the screen without proper blinking, leading to blurred vision. It is also a temporary adjustment disorder caused by excessive eye force attempting to focus on constantly changing VR images.

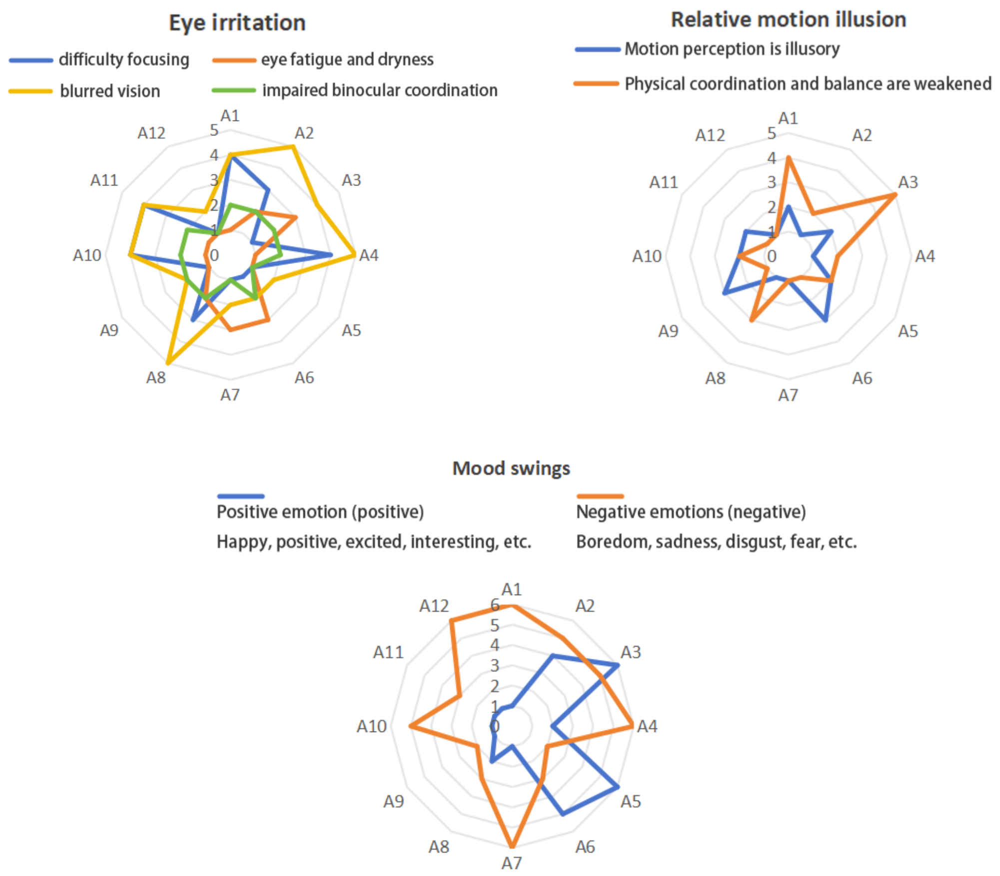

Figure 5. Physiological response.

It can be seen that the binocular coordination of the tested subjects decreased during the testing process, indicating that the VR experience affected the collaborative work of the eyes, leading to depth perception problems in the visual experience. The decrease in body coordination and balance suggests a conflict between sensory input caused by VR and actual body movements. After watching VR videos, the majority of viewers developed a high level of positive emotions, such as happiness, positivity, excitement, and fun, indicating that VR content has successfully created an attractive visual experience. However, a minority of people experiencing negative emotions may indicate that VR content did not arouse the interest of participants, or triggered reactions of discomfort or even fear.

In summary, these physiological responses reveal the various effects of physical stress, sensory conflict, visual fatigue, and balance disorders on participants during watching VR videos. These results provide important basis for improving VR experience design in the future, such as reducing user discomfort through optimizing visual presentation, reducing latency, adjusting content complexity, and enhancing the positive effects of immersive experiences.

6.3. Visual experience

High contrast can help users better distinguish different objects and environmental features, while increasing saturation can make colors more vivid, thereby enhancing visual impact. However, excessive saturation may lead to color distortion, causing colors in the virtual environment to no longer match those in the real world, which may affect users' spatial perception and object recognition. And depth of field refers to the range of clear areas in an image from foreground to background. In the real world, the human eye observes objects at different distances by adjusting the focal length, and this ability is achieved in virtual environments by simulating a similar sense of depth. The correct depth of field not only enhances the realism of the virtual environment, but also helps users determine the distance between objects, avoiding collisions or incorrectly estimating distances (as shown in Figure 6).

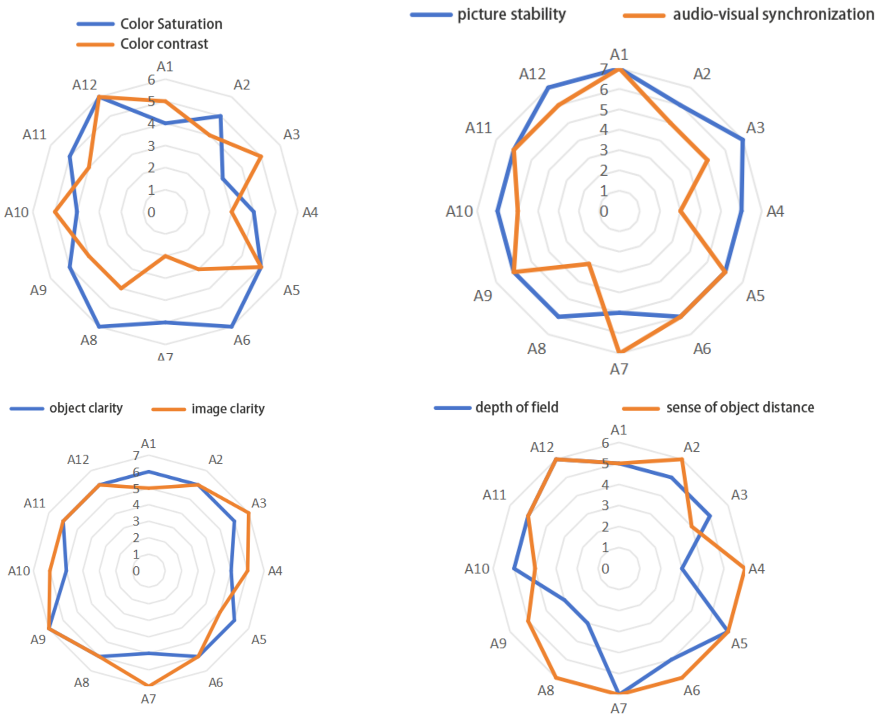

Figure 6. Visual feedback.

In addition, the clarity of images and objects is a fundamental element in the user experience, which directly affects the user's perception of details in the virtual environment. High definition images and text can reduce visual fatigue and improve user recognition speed of the environment. If the clarity is insufficient, it may make it difficult for users to recognize small objects or text, thereby reducing immersion and user experience.

Audio visual synchronization and visual stability are also core elements of VR experience, especially in long-term use. Audio visual synchronization is crucial for avoiding user discomfort and maintaining immersion. If the video and audio are not synchronized, it may cause users to feel uncomfortable and interrupt their immersive experience. Screen stability is the foundation of a smooth experience and is crucial for reducing the occurrence of motion sickness. A decrease in frame rate or screen jitter may cause users to experience symptoms such as eye fatigue, headache, and even nausea, and in severe cases, may force users to stop using it.

In summary, the indicator design of this scale test is based on the latest achievements in visual science and user experience research, ensuring that its indicators can accurately reflect key aspects of VR experience, including multiple key visual and auditory indicators that have a significant impact on VR experience. We will further enhance its scientificity and practicality in the future, such as ensuring that all tests are conducted under controlled conditions to reduce the impact of external variables. And combine knowledge from fields such as psychology, cognitive science, and technology to ensure the comprehensiveness and accuracy of the scale.

7. Conclusion

In order to make the sinitic opera be inherited and widely spread, a description method of human motion has been established, which can not only preserve the artistry of dance, but also record the dance movements completely through mathematical models. The proposed human motion model takes the three-dimensional skeleton hierarchy of body as object, and described the dance movement of sinitic opera from the aspects of body structure, spatial orientation and movement force effect. The concise action description language and the identification method of performance style restore the ideographic function of dance to the maximum extent. This description method is applied in Digital Bingxi and Virtual Mei of intelligent media, realizing the creative transformation and innovative development of Chinese excellent traditional culture.

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