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The Movement Design of Dolls in the Western Region in the Exhibition Art Life and Stage

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Abstract: - Stage art is a combination of stage music, stage art, literature and other art forms, and it is a form of artistic expression that resonates with the audience by conveying certain ideas. With the widespread use of digital economy in many fields of life and the transformation of society, the border between stage art and life is gradually blurred, and the art form has become multi-dimensional and diversified, and everyone is in the art, enjoying the charm of art itself. Where, the design of the movement of dolls on stage has a more important role, this paper on the exhibition of art life and stage art, and combined with the actual case study to illustrate the effectiveness of this paper on the design of the movement of dolls. The experimental results show that the western region ancient style puppet action design method in this paper has a significant effect on improving the performance ability of the art stage, and brings a variety of inspiration to the puppet action design.

Keywords: movement design, western region, exhibition art, stage analysis

I. INTRODUCTION

With the gradual extension of art, the content of its creation has become more diversified, resulting in various kinds of works with highly contemporary themes [1]. The state attaches great importance to the extension of culture, encouraging its creators to dig deeper into the current content and to do a good job of passing it on based on the new historical background. Compared to other performance genres, China has developed its unique artistic appeal over a long period of time [2]. As an important component, stage art is presented to give people a deeper understanding of art. With its diverse content and rich forms, people's understanding of art has become more diverse. Understanding the modern development mode of art and analyzing the characteristics of art styles, recognizing the modern inheritance characteristics of art, can understand the unique beauty of art under specific conditions, and can also enhance people's appreciation of beauty[3].

In this vast land, since ancient times, there are not only numerous admirable material and cultural treasures on the Silk Road, but also many spiritual and cultural treasures that have attracted the attention of the world [4][5]: "The Western region is the domain of multi-ethnic activities, where many cultures collide, fuse and teach back, so the Western culture is a kind of Chinese regional culture at the intersection of Eastern and Western cultures with multiple sources, multiple coexistence and multi-dimensional development.

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In the western region of the Silk Road passages north and south of the Tianshan Mountains, the unearthed ancient theatrical music and dance art texts are very numerous and fine [6][7]. These striking literary achievements of the Silk Road have added a brilliant glow to traditional Chinese multi-ethnic culture [8].

Motion design technology is relatively mature and popular in the western antique industry. The capture system captures and specifically processes the motion data of professional artists, and then binds it to the role model in the photographic visual works to obtain 3D virtual animation. At present, the spatial position acquisition system is mainly divided into two categories: sensor acquisition and optical acquisition. The former is relatively mature, which is characterized by high transmission speed, more accurate location data, higher cost, and may be inconvenient to carry equipment. In contrast, optical capture. In contrast, there are two types of optical capture: unmarked and labeled. This document is designed for a no catch marking system, which uses conventional 2D images or videos as the input of target recognition and feature analysis to capture body joints [9]. Although they have not been widely used due to their instability, their advantages such as availability, flexibility and low cost should not be ignored.

II. RELATED WORK

2.1 Design methods derived from animation theory

Animation design is an artistic process, and its guiding principles are different from controlling the movement of puppets and robots. The twelve basic principles of character animation have been widely recognized by practitioners. Animators can use keyframes and dance to edit action sequences, adding fine functionality and detail to character animation. Several studies have shown that applying animation principles helps participants to interact with human figures[10, 11].

Several human-computer interaction studies have used these animation design principles when designing the movements of the dolls. Trenton's study applied the principles of slow-in, slow-out animation to optimize the movement profile of the dolls, which significantly improved the affinity and sense of life of the dolls [12]. The study [13] advocated applying these principles to the dolls, and he applied some of them to the iCat's face to make the expressions more natural and less robotic. This leads to people treating the dolls as if they were alive. Another example is the use of exaggeration in storytelling with dolls. The exaggerated movements of the dolls allow participants to better remember specific parts of the story [14], therefore, applying animation principles to the dolls changes the way people interact with them. Dolls cannot perform certain behaviors on animated characters. For example, animated characters can swing their arms as fast as the animator, but the doll's arms must be within the allowed speed and acceleration range.

2.1.1 Frame-by-frame animation

Frame-by-frame animation invented by an unknown technician in 1907, frame-by-frame animation was initially used as an experimental video to make a splash in early film and television [15]. At first, this technique was not known to the world, but later, Emile Cole in France discovered this unique technique and produced many excellent early frame-by-frame animation masterpieces, such as the frame-by-frame stop-motion puppet show "Little Faust", see Figure 1 [16-17]..

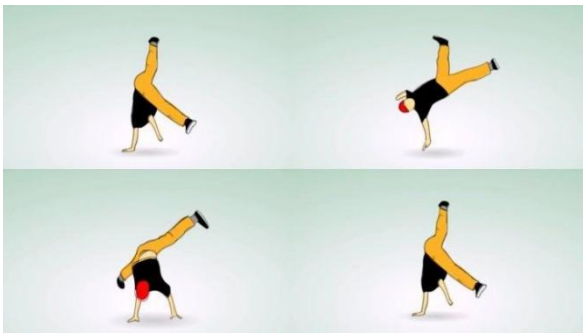

Figure 1 Frame by frame animation example

2.1.2 Key frame animation

As shown in Figure 2, keyframe animation is firstly drawn by the artist to draw the keyframe, and then the assistant will supplement the screen between keyframes according to the standard shape of the character, the specified range of motion and the movement pattern. The key frame drawing is later called the original drawing, and the drawing between the original drawing and the original drawing is called the intermediate drawing[18]. Keyframe animation usually only depicts the characteristic form and characteristic movement.

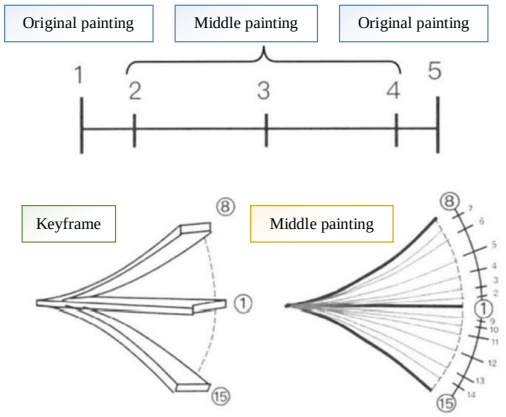

Figure 2 Keyframe animation schematic

2.2 Design methods derived from the Laban framework

Laban Movement Analysis (LMA) is a set of methods used to describe, represent, interpret, and record all human movement, originally proposed by Rudolf Laban [21]. Rudolf Laban (1879-1958) was born into an aristocratic family in Austria-Hungary and studied architecture in France to study architecture, during which he became interested in the relationship between the form of human movement and space [22]. Later, his research began to focus on the form of human movement and slowly formed his own theory. This theory is divided into four parts: Body, Effort/Dynamics, Shape, and Space [23]. Among them, the most relevant to action design is the theory of action part, which is also called Laban Action System (LES, that is, Laban Effort System) [24][25].

III. METHOD

As shown in Figure 3, the strengths and weaknesses of the ancient style dolls determine the problems that will arise in the design process. The power part of the design problem is considered how to promote, and the solution strategy

is proposed for the obstruction part, based on which the design process is considered comprehensively and the design method is proposed. Ancient style dolls have the advantages of low cost, lightweight, easy to make, and rich modeling, but also have the disadvantages of less freedom, single drive mode, movement is limited by the structure, programming development has a certain threshold. One of the advantages can be used as a driving force in the design, such as to help the rapid iteration and achieve rich modeling performance. The disadvantages can be a hindrance to design, including the shape of a variety of changes will lead to design students can not quickly distinguish between static and movable structures, there is a large threshold for hands-on use of movable structures[19,20]. Secondly, there are fewer degrees of freedom of action leading to the convergence of action expression, structural restrictions on the way to drive and complex action to achieve the process of programming difficulties.

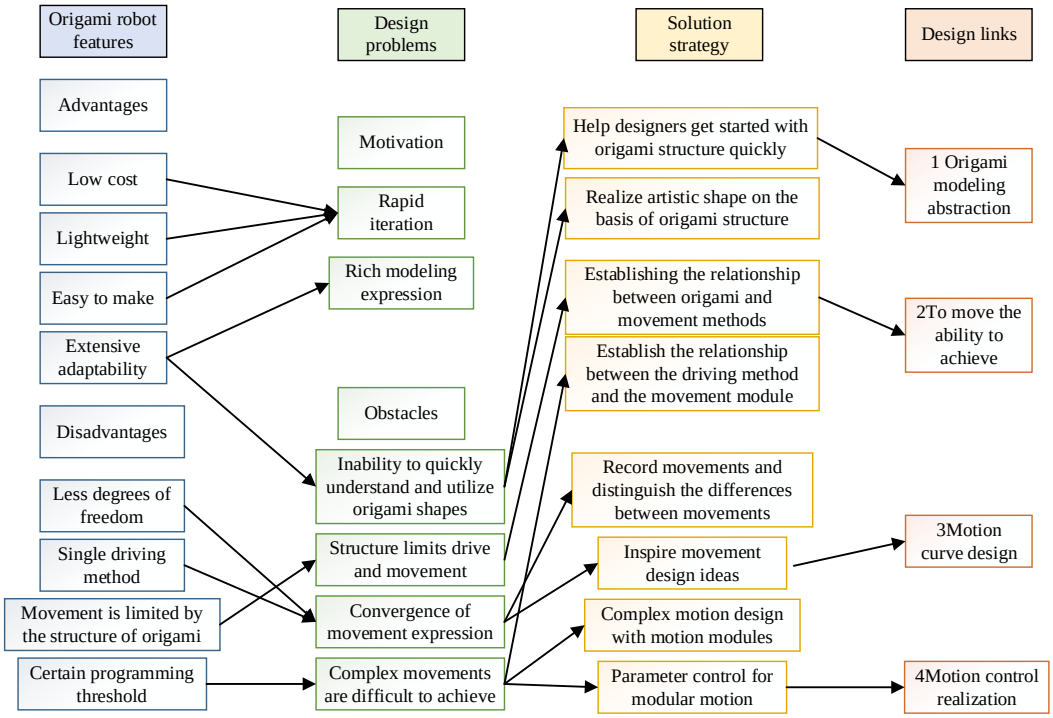

Figure 3 Design method construction ideas

3.1 Motion design process overview

Ancient style doll action design involves the knowledge of several disciplines, character modeling belongs to the art design, drive structure needs to learn the basic principles of mechanical mechanisms; action design involves electromechanical power and logic design of digital and analog signals, and the final motion control needs to be realized by software writing program. The design flow chart is shown in Figure 4.

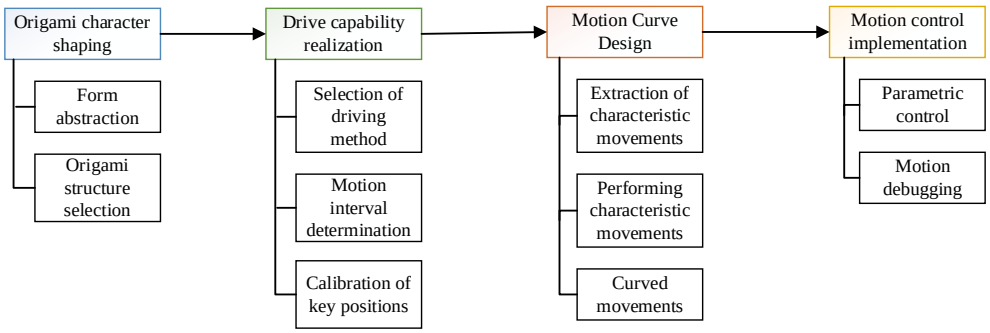

Figure 4 Motion design process

In the process of character shaping, abstract design thinking needs to be used to design the image of the character, while the structure needed for that image needs to have freedom of movement. After that, the folding drawings are drawn according to the folds of the structure. In the process of drive capability realization, the appropriate drive mode should be selected according to the structure, and after determining the motion interval of the structure, the key position of the motion should be marked to provide the basis for the subsequent motion design.

The character can be designed both from the movable structure and from the image of a real creature. The design process is shown in Figure 5.

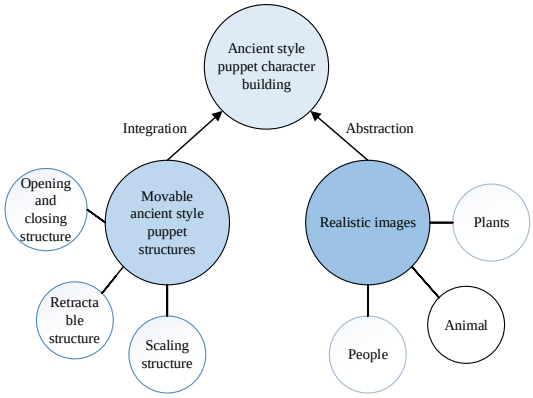

Figure 5 Character building process

Once the ancient style puppet has a form, the next step is to consider how to provide power to the ancient style puppet. Ancient style puppet are different from normal humanoid ancient style puppet in that they have multiple joints and multiple degrees of freedom. Most of the robots are driven by only one or two servos, and the degrees of freedom of the ancient style puppet are very limited. The drive capability is realized in two key steps, as shown in Figure 6, which are 1) choosing the appropriate drive method according to the structure and 2) calibrating the key position for the range of motion of the structure.

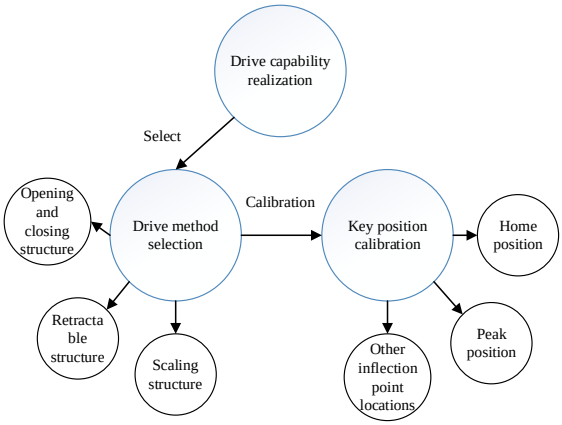

Figure 6 Drive capability realization design process

After determining the basic shape and driving method of the ancient style dolls, the next step requires the motion design of the ancient style dolls. The output of the motion design is the motion curve of the action. In the design process, it is necessary to observe, understand, imitate and create the key postures, physiological phenomena, emotional expressions, body movements, event behaviors and other activity states of the robot characters. Ultimately, the vivid movement design is used to shape full-bodied characters, portray stories, create a sense of scene, and convey interesting events, emotions, attitudes, and intentions of the ancient style dolls. Establish friendly human-computer interaction. The steps to perform action curve design are shown in Figure 7. This study will detail the method and process of curve design in this section.

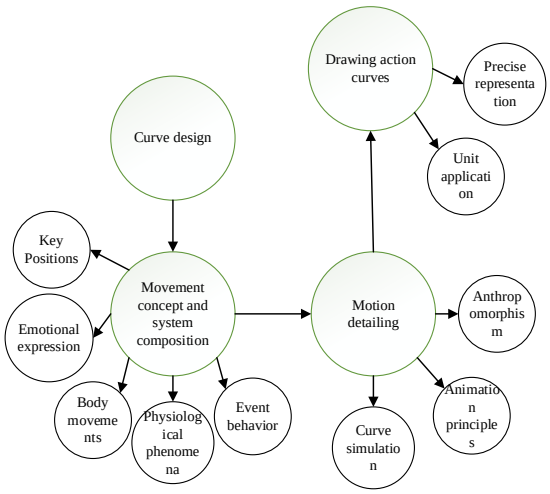

Figure 7 Step-by-step diagram of action curve design

From the actual use of some models, this paper addresses the above problems by proposing a correction unit under the time-domain graph convolutional neural network model to improve the accuracy of pose capture by using the prior knowledge of human motion to assist the training of the network. The output 3D pose data is converted to a format that can be imported into 3D animation design software to bind with various virtual character models, and finally a simple and efficient capture system is realized, and the model structure is designed as in Figure 8.

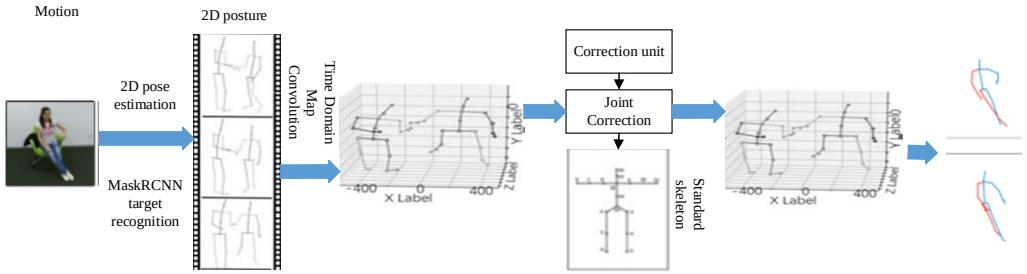

Figure 8 The mannequin action design network based on the correction unit

3.2 Depth estimation

$P=\left(x_p, y_p, z_p\right)$, where z_p denotes the distance to the camera. The lack of support conditions for estimating the distance only from two-dimensional images led to the design of a new measurement scale k.

$$k=\sqrt{\alpha_x \alpha_y \frac{A_{real}}{A_{img}}} \quad (1)$$

The distance d can then be obtained according to the imaging principle.

$$d=a_x \frac{l_{x,\,real}}{l_{x,img}}=a_y \frac{l_{y,\,real}}{l_{y,img}} \quad (2)$$

Moreover, the computational complexity of different key points of the human figure's posture is different. The head and torso are easy to detect and infer, while the extremities, especially the wrist and elbow joints, knee and ankle joints, are the most ambiguous. Therefore, the pose correction unit is optimized in two scales, local and global, as shown in Figure 9. The ambiguity of the 3D pose is specifically manifested in the coordinates of the joint points and the length and orientation of the bones. As mentioned in Chapter 2, the standard model of each character needs to be collected before the pose estimation, and the bone length is mainly obtained from the 2D pose output of the standard model, and the standard bone length becomes a powerful reference for optimizing the 3D output, and this method is called anthropometry.

Based on the predefined skeletal topology and the standard model, the joint connection qualification and the trajectory space qualification (as shown in Figure 10) can be used to optimize the skeletal orientation. However, the magnitude and direction of the contact forces are dynamic, and it is a challenging task to analyze such dynamics comprehensively. The support force of the ground on the mannequin comes from the feet, denoted by $f_r, f_l \in \Re^3$ respectively, and the support force and the combined force of the mannequin $F \in \Re^3$ are a pair of interacting forces. The manikin dynamics is analyzed to find f_r, f_l.

$$F=\sum_{i=0}^{J}\left(m_i^{\&\&} F_i+m_i g\right) \quad (3)$$

$$\sum_{i=0}^{J} m_i^{\&\&} F_i = MC^{\&\&} \quad (4)$$

$$MC^{\&\&} = f_r + f_l + Mg \quad (5)$$

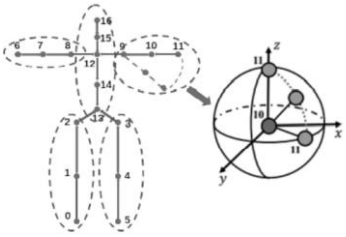

Figure 9 Pose parent-child joint association and symmetrical structure diagram of the human figure pose

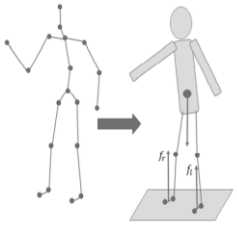

Figure 10 Structure of the simplified model of human figure kinematics and mechanics

IV. CASE STUDY

To explore the expressiveness of expressive movements of ancient dolls, a validation experiment was designed in this study. The experimental framework is shown in Figure 11.

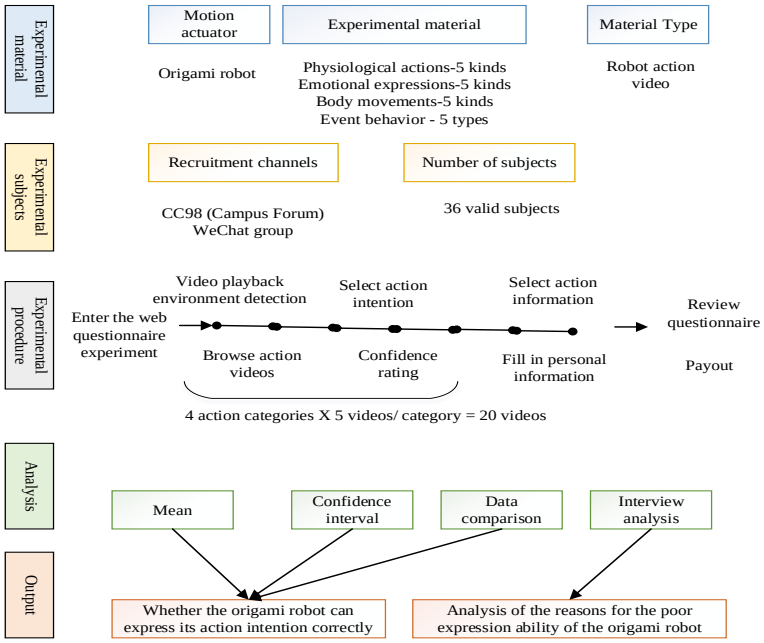

Figure 11 Experimental design framework for validating the movement expression ability of ancient dolls

4.1 Experimental design

4.1.1 Experimental materials

From the actions designed in the Expressive Actions Workshop for Ancient Style Dolls, five types of actions with large gaps in expressive intent were screened according to the four categories of expressive action series, and the list of actions is shown in Table 1. The screening process was carried out with the category as the dimension, and the action expression was not limited to a certain ancient style doll. For example, the awakening action is from the peacock, the breathing action is from the puffer fish, and the sleeping action is from the bird. The reason for this is that a single ancient style figure has a limited range of expressions and cannot realize multiple actions of the same category at the same time.

Table 1 Expression ability verification experiment material

Action Category	Action Transfer Intent				
Physiological action	Awakening	Breathing	spiteful awareness	tremble	Wake up in fear
Emotional expression	Pleasure	Excitement	aggravation	startled	Fear
Body movements	Fly right	Fly to the left	small broken step	Gently hand and foot	Run to the side
Event behavior	Provoke	Quarrel	Singing	Greeting	Running away

4.1.2 Experimental subjects

The experiment was conducted by means of an online questionnaire. 37 people participated in the experiment, and one of them completed the experiment in a very short time of 4 minutes and 38 seconds and was judged to be an invalid sample. 36 people were valid samples, and all of them received a fee of 6.6 yuan. Among the valid samples, 22 were male and 14 were female, aged between 20 and 30 years old, with an average age of 23.56 years old. There were 11 undergraduates, accounting for 31%, and 25 postgraduates, accounting for 69%, and the subjects were from various majors. The questionnaire completion time ranged from 6 minutes and 10 seconds to 19 minutes and 38 seconds, with an average completion time of 9 minutes and 47 seconds.

4.1.3 Experimental process

The experiment was conducted through a web-based questionnaire, and the basic flow of the questionnaire is shown in Figure 11. After each video, participants were asked to complete two questions, which were divided into two dimensions.

1) What words are used to describe the movement of the ancient style dolls (single choice)

2) What do you think is the message the ancient style dolls are trying to convey? (Single-choice question) The specifics of the question options were adapted to the categories of movements in the video, as shown in Table 2.

Table 2 Table of question options for each type of action

Physiological Action Question Options						
Question 1	Awakening	Breathing	spiteful awareness	tremble	Wake up in fear	Neither
Question 2	With a sense of life	No sense of life	Neither			
Emotional Expression Question Options						
Question 1	Pleasure	Excitement	aggravation	startled	Fear	Neither
Question 2	Positive emotions	Negative emotions	Neither			
Limb Motion Problem Options						
Question 1	Fly right	Fly to the left	small broken step	Gently hand and foot	Run to the side	Neither
Question 2	To the left	To the right	Neither			
Event Behavior Problem Options						
Question 1	Provoke	Quarrel	Singing	Greeting	Running away	Neither
Question 2	Expressing friendliness	Attacking/being attacked	Neither			

4.1.4 Analysis of experimental data

The analysis of physiological action expression ability is shown in Figure 12. Only two of the five physiological actions (shivering and waking up) have a high recognition rate, while the recognition rate of the other three actions (waking up, breathing and sleeping) is below 50%. The statistics of the incorrect answers showed that the "wake up" action was identified as the "breathing" action most often, and the "breathing" action was confused with the "sleep" action. The "breathing" action was confused with the "sleeping" action.

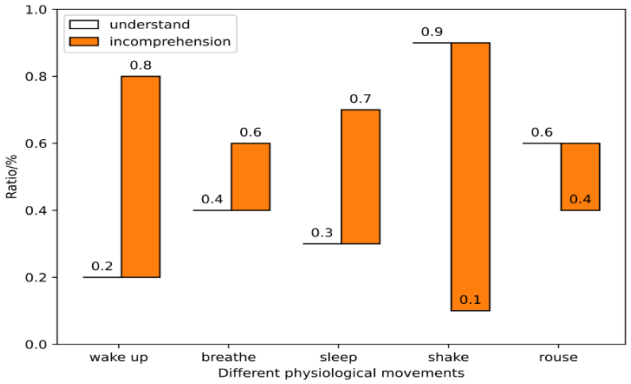

Figure 12 Recognition rate of five physiological movements

As shown in Figure 13, we can see that all five actions can convey the sense of life well by analyzing the communication rate of whether the five physiological actions can convey the sense of life. Among them, the recognition rate of "sleeping" is the lowest. After user interviews, we know that the action of "sleeping" is relatively calm and inactive, and will be interpreted as "dying" in the absence of contextual factors in the scene. "Therefore, some subjects thought that "sleep" was lifeless. It is worth acknowledging that although the subjects could not distinguish between the actions of "awake", "breathing" and "sleeping", they were able to understand the sense of life in the old-fashioned dolls through the actions. Although the participants could not distinguish accurately whether the puppet was "sleeping", "awake" or "breathing", the movement design is successful when the puppet is felt to be alive. It also shows that the conventional physiological movements of coordination can not be distinguished, but it does not affect the higher level of the message of life.

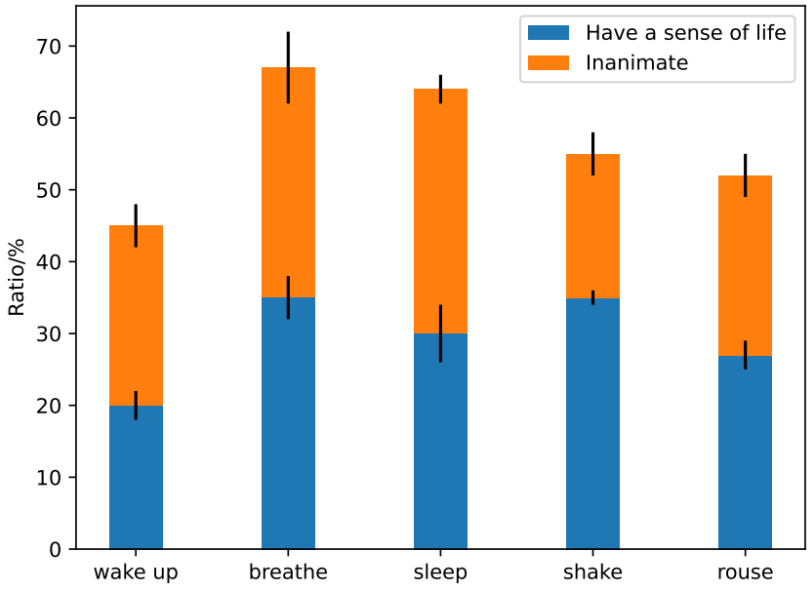

Figure 13 Key information conveyance rate of five physiological movements

4.2 Analysis of body movement expression ability

As shown in Figure 14, most of the movements were correctly identified, with the highest recognition rate of "small steps" and the lowest recognition rate of "fleeing to the side". By analyzing the wrong answers, we found that "fleeing to the side" was identified as "neither" most often. Through the interview, we learned that "running to one side" was expressed by the fish's swimming, and the fish's head swung from side to side during the "swimming" process, so the subjects thought that the fish swam in more than one direction and had multiple directions at the same time, so they did not think the action was expressing "to one side". The fish's head swings from side to side during "swimming". Also, the process of "swimming" was not understood as "escaping" because of the lack of context.

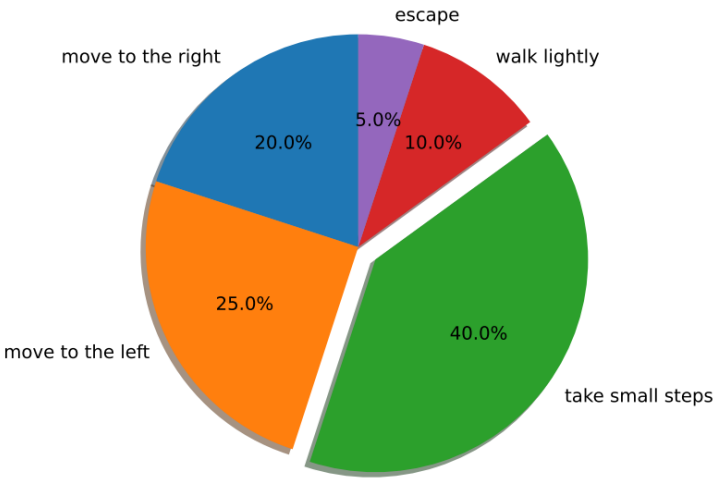

Figure 14 Recognition ratio of five kinds of body movements

The core information conveyed by the body movement is the directionality of the movement. Thus whether the subjects could identify the direction of the limb movement is called the key. By analyzing the percentage of correct communication of the key information of the five body movements, we can see that most of the movements were correctly understood. The communication rate of "small step" was the highest, and the communication rate of "flee to ~ side" was the lowest. The interview revealed that the directionality of the "flee to one side" action was not clear, so the subjects chose "neither" the most.

4.3 Analysis of event behavior expression ability

As shown in Figure 15, the recognition rates of "quarrel", "singing", "greeting" and "running away" among the five event behaviors are relatively high. "The recognition rate of "singing" is the highest, and the lowest is "provoking". As shown in Figure 23, by analyzing the wrong answers, "provocation" was recognized as "greeting" most often, and "singing" was recognized as "singing" second most often. The interview revealed that the "provocative" action had a clear intention of showing off and showing off. Due to the lack of context, they were interpreted as "greeting" and "singing" when the subjects did not feel the aggressiveness.

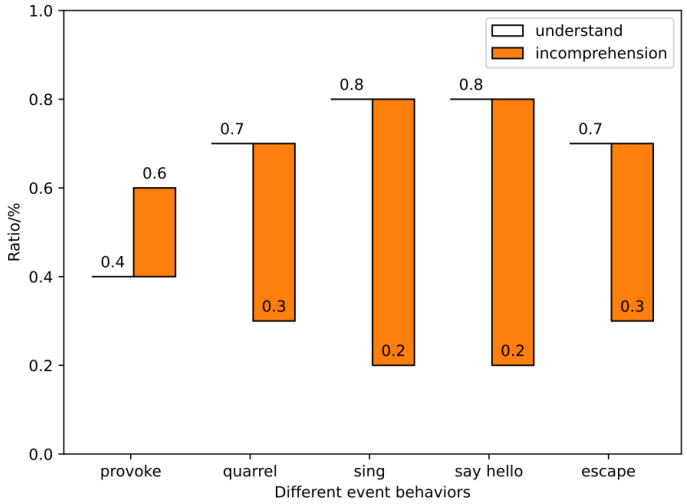

Figure 15 Recognition rate of five event behaviors

Through the analysis of the interviews, when the ancient style puppet sings a monologue to express the event behavior, because of the lack of dialogue with the person, the lack of context, there will be misunderstanding of information, such as the attacked "escape" as a simple "crawl", but do not understand the actual scenario in which the ancient style doll is placed. The expression of the event behavior should be generated through the interaction between the participant and the Goofy doll, see Figure 16.

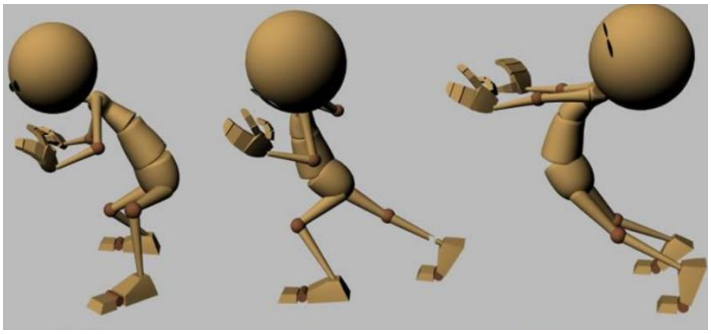

Figure 16 Balance correction effect of dolls

V. CONCLUSION

This paper focuses on the creation characteristics, creation meaning and creation methods of the western ancient style theme doll works, revealing the profound artistic value and cultural value of the western ancient style works, hoping that the creator makes the creation with a realistic attitude, creating fine works We hope that the creators will make creations with a realistic attitude, create fine works, and promote the development of the creation business. With the help of hologram, 3D and other high-tech, from a two-dimensional plane form gradually into three-dimensional space form and art direct interaction, life gradually and stage art into one, the stage art is no longer high, sacrosanct, inaccessible to people.

REFERENCES

[1] Ukeles, M. L. (2018). Manifesto for Maintenance Art 1969! Proposal for an exhibition" CARE". *Journal of Contemporary Painting*, *4*(2), 233-238.

[2] Yakovets, I., Gamaliia, K., Opaliev, M., Zhadeyko, O., & Fomina, K. (2021). Formation of exhibition art space in the context of project culture development. *REVIEW OF INTERNATIONAL GEOGRAPHICAL EDUCATION*, (11), 2460-2468.

[3] Shen, X., Wang, L., & Ge, M. (2022). The Soul Trembles: An Exhibition of Shiota Chiharu's Art and Design Work. Long Museum West Bund, Shanghai, China, 12 December 2021–6 March 2022. *The Design Journal*, 1-10.

[4] Li, Y. (2020). Art and Technology Exhibition under the Context of Artificial Intelligence. *IFAC-PapersOnLine*, *53*(5), 103-105.

[5] Dunaway, J. (2020). The forgotten 1979 MoMA sound art exhibition. *Resonance: The Journal of Sound and Culture*, *1*(1), 25-46.

[6] Cai, G., Xu, L., Gao, W., Hong, Y., Ying, X., Wang, Y., & Qian, F. (2020). The positive impacts of exhibition-driven tourism on sustainable tourism, economics, and population: The case of the Echigo–Tsumari Art Triennale in Japan. *International*

journal of environmental research and public health, *17*(5), 1489.

[7] Puurveen, G., Cox, S. M., Damiano, N., Furneaux, H. N., & Sierra, S. P. (2022). Co-creating an Art Exhibition on Living Well With Dementia. *AMA Journal of Ethics*, *24*(7), 622-633.

[8] Lee, T. S. C. (2020). Curriculum based interactive exhibition design and family's learning experiences: a case study of the children's art museum in Taipei. *Curator: The Museum Journal*, *63*(1), 83-98.

[9] Sadeghi, Y., & Islam, G. (2021). Modes of exhibition: Uses of the past in Tehran art galleries. *Organization*, 13505084211041713.

[10] Mpofu, S. (2019). Art as Journalism in Zimbabwe: The case of Owen Maseko's banned Zimbabwean genocide exhibition. *Journalism Studies*, *20*(1), 60-78.

[11] Su, S. (2021). Exhibition as Art Historical Space: The 1933 Chinese Art Exhibition in Paris. *The Art Bulletin*, *103*(3), 125-148.

[12] Smith, B. (2021). Prix De West: The World's Premier Western Art Exhibition & Sale. *Sculpture Review*, *70*(1), 33-48.

[13] Chica, A. T. D. L. (2020). Towards a scientific exhibition of art: comparative study (Pereira, Madrid). *Revista Lasallista de Investigación*, *17*(2), 50-59.

[14] Ferrer, C. (2022). "Avant-garde videotape", first exhibition of video art in Mexico. *Índex, revista de arte contemporáneo*, (13), 49-66.

[15] Zavarce, E., Machado Penso, M. V., Molero, N., & Hernández, S. (2022). Art as a Transformative Collaboration: A Journal of Vital Encounters to Create the Virtual Exhibition Confined Bodies. *Art Education*, *75*(5), 45-47.

[16] Wildenhaus, K. (2019). The Possibilities of Constructing Linked Data for Art Exhibition Histories. *Art Documentation: Journal of the Art Libraries Society of North America*, *38*(1), 22-34.

[17] Kennedy, I. (2018). The 'Wrexham Art Treasures' exhibition of 1876. *The British Art Journal*, *19*(3), 80-86.

[18] Grant, J. (2020). Understanding Perceptions of Community though Community Art and Storytelling from National Louis University's Rotating Art Exhibition. *SPACE: Student Perspectives About Civic Engagement*, *4*(1), 3.

[19] Bani Ebrahimi, M., & Teimoori, T. (2022). Geography of Art in Islamic and Western Architecture: A Study of Important Elements in Museum and Exhibition Design. *Geography (Regional Planning)*, *12*(4), 876-905.

[20] Fees, S. (2019). Artist combines science, art in exhibition on Statesboro Campus. *Center for Art & Theater News*, *2*, 11-2019.

[21] Mantas, K., & Roy, C. (2020). Virtual Art Exhibition: Learning, Teaching and Transformation Juried Exhibit. *Canadian Journal for the Study of Adult Education*, *32*(2), 165-190.

[22] Jingchun Zhou, Dehuan Zhang, Weishi Zhang. Cross-view enhancement network for underwater images. Engineering Applications of Artificial Intelligence, 2023, 121, 105952.