www.cad-journal.net
Computer-Aided Design AND APPLICATIONS

Visual Presentation Algorithm of Dance Arrangement and CAD Based on Big Data Analysis

Lingmei Hu

School of Music and Dance, Hunan University of Science and Engineering, Yongzhou, Hunan 425199, China, hlm992299@huse.edu.cn

Corresponding author: Lingmei Hu, hlm992299@huse.edu.cn

Abstract. The purpose of this article is to explore the application of big data analysis in dance choreography and bring new innovations and breakthroughs to dance art by combining CAD visual presentation technology. In terms of methods, this article extracts the characteristics and laws of dance movements through in-depth mining and analysis of dance movement data and constructs a dance arrangement model based on big data. At the same time, the 3D modelling and rendering of dance movements are realized by using CAD visual presentation algorithm, which provides a more intuitive and realistic viewing experience for the audience. The results show that the CAD visual rendering algorithm evaluated in this article has excellent performance in rendering speed and image quality. The dance choreography model based on big data can effectively generate innovative and artistic choreography schemes and improve choreography efficiency and audience satisfaction. The technology of CAD visual presentation offers a fresh and innovative approach to exhibiting dance movements, enabling the audience to experience the allure and vivid elegance of dance more profoundly. By introducing big data analysis and CAD visual presentation technology into the field of dance arrangement, this article realizes the scientific and artistic dance arrangement, which provides new possibilities for the inheritance and development of dance art.

Keywords: Big Data; Dance Arrangement; Computer-Aided Design; Visualization
DOI: https://doi.org/10.14733/cadaps.2024.S21.325-340

1 INTRODUCTION

Dance, as an ancient and vibrant art form, has been developing its arrangement with the changes of the times. With the advancement of technology, motion capture technology has become an important tool for studying dance movements. Behrouzpour et al. [1] explored how to use motion capture systems to transform human dance movements into music-based conceptual paintings and conducted in-depth action research on them. Through this transformation, it can further understand the inherent connection between dance, music, and painting and provide new ideas and methods for artistic creation. By utilizing motion capture systems, it is possible to accurately record and measure

the movements of dancers in three-dimensional space. This digital approach not only provides detailed data information but can also be further processed and processed through computer software. Through this approach, it is possible to delve deeper into the subtleties of dance movements and preserve and present them in digital form. By utilizing motion capture systems, dance movements can be transformed into digital data. These data can be further processed and transformed to form music-based conceptual paintings. From early manual choreography to modern computer-aided design, the evolution of dance choreography technology not only improved the creative efficiency but also greatly enriched the expressive force of dance art. In the digital age, the integration of dance art and digital humanities provides new perspectives and tools for the study of dance history. The archives, as a gathering place for dance historical materials, provide rich resources for the visual representation of dance choreography. Bench and Elswitch [2] discussed how to use CAD technology, combined with visual representation algorithms for dance choreography, to digitize historical materials in dance archives, providing a more intuitive and in-depth perspective for dance history research. Develop corresponding arrangement rules and algorithms based on the historical evolution and stylistic characteristics of dance. These rules and algorithms are used to guide how to reasonably combine and optimize the extracted action data to form a dance arrangement with historical characteristics. It presents the choreographed dance action data through visual means, such as animation demonstrations, virtual reality, etc. This visualization method helps researchers to have a more intuitive understanding of the historical evolution and stylistic characteristics of dance, providing strong support for the study of dance history. However, the traditional choreography methods often rely on the personal experience and intuition of the choreographer, lacking scientific and systematic data support, which limits the possibility and innovation of dance creation to some extent.

Dance training posture motion capture has been a hot research topic in recent years, to accurately capture the posture and movements of dancers during training through technical means, in order to analyze and evaluate them. Chen et al. [3] explore how to use mathematical similarity-matching statistical analysis methods to conduct motion capture research on dance training postures, in order to improve the scientificity and accuracy of dance training. The mathematical similarity matching statistical analysis method is a tool based on mathematical models and statistical analysis, which can conduct in-depth research and analysis on dance training postures. By using mathematical similarity matching statistical analysis methods, feature extraction can be performed on dance training postures, such as joint angles, limb lengths, etc. These features can be used to describe the characteristics and patterns of dance movements, providing basic data for subsequent motion capture and analysis. Based on the extracted posture features, mathematical similarity-matching statistical analysis methods can be used to match and recognize dance movements. By comparing the similarities between different dance videos or datasets, we can discover the inherent connections and variation patterns between dance movements. With the development of technology, motion capture technology has been widely applied in sports training. Especially in aerobics training, precise capture and analysis of athlete movements can help coaches and athletes better understand technical movements and improve training effectiveness. Chen et al. [4] explored how to use mathematical similarity matching and statistical analysis methods to capture posture movements in aerobics training. Use high-precision motion capture equipment to capture the training posture of aerobics athletes. The device typically includes multiple infrared or ultrasonic sensors that can track and record the athlete's movement trajectory and posture data in real time. Preprocess the captured data, including removing noise, smoothing data, etc., to obtain more accurate motion data. Then, convert the data into mathematical models for further statistical analysis. Using mathematical similarity matching methods to compare and analyze different training postures of different athletes or the same athlete. By calculating the similarity between different postures, the best training posture or potential technical issues can be identified.

Dance is a unique art form that expresses emotions and stories through body language and dynamic postures. In recent years, with the rapid development of computer vision and artificial intelligence technology, non-rigid 3D dance pose reconstruction has become a highly focused research field. Fan et al. [5] focused on exploring how to achieve high-precision recognition methods

in a non-rigid 3D dance pose reconstruction. Non-rigid 3D dance pose reconstruction refers to the process of accurately capturing, analyzing, and reconstructing the movements of dancers through computer technology. This technology can not only help dancers better understand their body language and movement skills but also provide richer creative materials and inspiration for dance choreographers. In addition, non-rigid 3D dance posture reconstruction also helps to improve the viewing and artistic quality of dance performances, bringing a more stunning and immersive visual experience to the audience. With the advancement of technology, more and more technologies are being applied to dance teaching. Among them, image optical detection technology based on dynamic time-warping algorithms has become a highly concerned research field. This technology provides detailed information about dance movements through precise analysis and processing of dance videos, thereby helping teachers better guide students in dance techniques. Huang and Zhu [6] discussed how to apply this technology to dance teaching to improve teaching quality and student learning outcomes. Dynamic time warping algorithm is a technology based on image processing and computer vision, which can extract keyframes from dance videos and compare them to discover subtle differences in dance movements. The dynamic time-warping algorithm can also be used to evaluate students' dance styles. By analyzing students' dance videos, teachers can understand the characteristics of their movements in terms of rhythm, fluency, and coordination, thereby evaluating their dance style and expressive power. By comparing dance videos of students at different time points, teachers can evaluate their training effectiveness and level of progress. This objective evaluation method helps teachers better guide students and help them develop more effective training plans.

Big data analysis can reveal the laws and trends hidden behind the data through the mining and processing of massive data and provide a scientific basis for decision-making. In the field of dance choreography, the application of big data analysis technology is expected to change the traditional creative mode so that the choreographer can more accurately grasp the audience's aesthetic preferences, the popular trend of dance movements, and the internal relationship between different dance elements, thus creating excellent works that meet the needs of the time. At the same time, the advantages of CAD technology in visual presentation also provide strong support for the innovation of dance art. Through CAD technology, choreographers can transform abstract dance movements into intuitive three-dimensional models and realize dynamic display and interactive editing of dance works. Not only does this enhance the efficiency and precision of dance creation, but it also reduces the barriers to entry, thus igniting the creative spark within a wider audience. Consequently, exploring the algorithms behind choreography and CAD visualization, grounded in big data analysis, carries immense theoretical and practical importance.

There are several innovations in this study:

A. This article introduces big data analysis technology into the process of choreography. Through the in-depth excavation and analysis of a large number of dance movement data, the characteristics and laws of dance movements are extracted, which provides scientific and objective data support for dance arrangement and makes the arrangement process more accurate and efficient.

B. This article not only analyzes the dance data but also constructs a dance choreography model based on big data. This model can automatically generate an innovative and artistic arrangement scheme, which not only retains the aesthetic feeling of traditional dance but also injects new creative elements, thus improving the quality and appreciation of dance works.

This article comprises seven distinct sections, each meticulously structured as follows:

Section I: The Introduction section primarily presents the backdrop and relevance of the research, along with its goals, challenges, and the overall outline of the paper.

Section II: Literature review, which will elaborate on the related theories and research status of dance choreography, big data analysis, and CAD visual presentation technology in detail and provide theoretical support for the follow-up research.

Section III: research methods and data sources, which will introduce the specific research methods, data sources, and processing procedures adopted in this study.

Section IV: Research on dance choreography based on big data analysis, focusing on how to use big data analysis technology to mine the characteristics and laws of dance movements and build the corresponding dance choreography model.

Section V: Research on the algorithm of CAD visual presentation, which will introduce in detail the selection of CAD visual presentation technology, the three-dimensional modelling and rendering of dance movements, and the design and implementation process of the visual presentation algorithm.

Section VI: Empirical research and analysis, which will verify the effectiveness and practicability of the dance arrangement method based on big data analysis and CAD visual presentation algorithm through empirical research and further discuss and explain the empirical results.

Section VII: Conclusion and prospect, which will summarize the main findings and contributions of this study and put forward the direction and prospect of future research.

2 RELATED WORK

With the rapid development of technology, big data analysis has shown enormous potential and value in many fields. In the field of dance choreography, the application of big data analysis provides new perspectives and tools for dance choreography, making the dance choreography process more scientific and accurate. Joshi and Chakrabarty [7] provide a comprehensive overview of dance automation choreography technology and its applications based on big data analysis. Based on machine learning algorithms, recognize and classify the collected dance action data. By training the model, the system can automatically recognize different styles of dance movements and classify similar movements. Based on dance action data and rules, use algorithms for automated choreography of dance. The algorithm can refer to different dance styles, music rhythms, and other factors to generate dance action sequences that meet the requirements automatically. In dance teaching, automated choreography technology can help teachers better understand students' technical movements and provide personalized teaching plans. Meanwhile, students can also engage in self-training and evaluation through automated choreography techniques. Social dance is a form of dance that is full of vitality and emotion. It is not only an artistic expression but also an important way for people to socialize and communicate. In recent years, with the development of deep learning technology, communicative dance recognition has become a hot research field. Matsuyama et al. [8] explored a deep learning-based communicative dance recognition method that combines three-dimensional pose estimation and wearable sensing technology to achieve perceptual classification of time and trajectory. It utilizes deep learning techniques to estimate the three-dimensional pose of the human body accurately. Firstly, wearable sensors are used to capture the dancer's motion data, including joint angles, motion trajectories, and other information. Then, these data are input into a deep neural network for training to achieve an accurate estimation of human posture. After obtaining human posture data, the time series analysis method is used to perceive the time trajectory of dance movements. By analyzing the temporal variation patterns of dance movements, we can gain a deeper understanding of the characteristics of dance, such as rhythm, speed, and fluency. With the advent of the digital age, dance art has gradually moved from a traditional stage to a broader digital space. Digital technology provides new ways of expression and dissemination for dance, enabling dance works to be presented in more diverse forms to the audience. Suani et al. [9] explored how to use multimedia and digital technology to convey visual dance to the digital age, and how to ensure the inheritance and development of dance culture by protecting and enriching dictionaries. By utilizing multimedia technology, audiences can participate in dance performances through interactive means, adding fun and interactivity to dance performances. This interactive form of dance performance can attract more audiences and enhance the dissemination effect of the dance. Through virtual reality (VR) and augmented reality (AR) technology, audiences can immerse themselves in the charm of dance. This immersive experience allows the audience to have a deeper understanding of the theme and emotional expression of the dance work, thereby enhancing the visual impact of the dance. Multimedia technology provides rich dynamic images and sound effects for dance performances, making dance works more diverse in

both visual and auditory aspects. This multi-dimensional presentation helps to expand the expressive and infectious power of dance.

With the advancement of technology, the application of computers in the field of design is becoming increasingly widespread. Among them, CAD (computer-aided design) technology has become an important tool in many industries, including dance action design. Traditional dance action design mainly relies on the experience and creativity of designers, but this method has certain limitations, such as difficulty in accurately expressing and communicating design intentions. The dance action design based on CAD computer three-dimensional assistance system provides a new way to solve this problem. Tan and Yang [10] use CAD technology to create models of dance movements in three-dimensional space. This model not only has a high degree of realism but also can accurately express every detail of dance movements, including body posture, motion trajectory, and speed. With the help of CAD technology, designers can dynamically simulate dance movements. Through simulation, designers can preview the dance action effects of their designs and make real-time adjustments, greatly improving design efficiency. With the advent of the digital age, big data technology has penetrated into various fields, including dance choreography. Big data analysis provides a new perspective and tools for dance choreography, making the process more scientific and accurate. Varela et al. [11] explored how to use big data analysis to visualize dance choreography and how to combine biomechanics and cultural context for dance analysis in digital dance academia. By utilizing sensors and motion capture technology, big data analysis can accurately record the movements of dancers, including trajectory, strength, rhythm, and more. These data provide a foundation for subsequent orchestration and optimization. Based on big data analysis, dance choreographers can identify shortcomings in their movements and optimize them by adjusting the motion parameters. This optimization process helps to improve the accuracy and technical level of dance performances. By comparing dance data from different styles and genres, big data analysis can help discover new dance elements and creativity, providing inspiration for choreographers. Dance, as a highly skilled and artistic sport, requires continuous analysis and research to improve performance levels. In recent years, the rapid development of deep learning and Internet of Things technology has provided new methods and perspectives for dance action analysis. Wang and Tong [12] discussed how to use deep learning and IoT technology for high-level dance action analysis. It utilizes deep learning techniques to automatically recognize and track the posture of dancers, including the positions, angles, and movement trajectories of various body parts. This helps dancers better understand their movement skills and posture. Deep learning algorithms can classify and recognize dance movements and automatically determine specific dance movements and styles by analyzing dance videos or sensor data. This helps dance directors quickly screen and edit dance materials. Deep learning can also be used to analyze emotional expression in dance. By analyzing the expressions, movements, and rhythms of dancers, the emotions and atmosphere conveyed by the dance can be determined, providing more inspiration for dance creation.

With the continuous development of technology, motion capture technology has become an important tool for studying dance and traditional Chinese opera movements. Through 3D motion capture technology, we can accurately measure and analyze the movement trajectory, posture, etc., of actors, thereby better understanding their movement skills and performance style. Wang [13] explored how to use three-dimensional motion capture analysis to assist traditional Chinese opera teaching and further explored the significance and value of this technology in dance education. Through three-dimensional motion capture technology, it is possible to conduct a detailed analysis of the movements of opera actors, including the movement trajectories, velocities, accelerations, etc., of various parts of the body. 3D motion capture technology can help teachers extract and classify the style features of opera actors. By comparing and analyzing the action data of different actors, teachers can better understand the differences and characteristics of various styles, providing support for the personalized development of actors. 3D motion capture technology can help students better understand their movement characteristics and styles and help them find suitable development directions in the field of dance. With the rapid development of technology, computer-aided perception image systems are increasingly being applied in various fields. In cultural and creative dance design, this technology provides designers with new tools and perspectives,

making design evaluation an important link. Xu and Zheng [14] discussed how to evaluate cultural and creative dance design based on computer-aided perception image systems. Through computer-aided perception image systems, the movements of dancers can be captured and recorded in real time. This digitized action data provides an objective basis for subsequent design evaluation. It utilizes a computer-aided perception image system to dynamically analyze dance movements, including analysis of motion trajectory, speed, force, and other aspects. This analysis can help designers better understand the inherent patterns and characteristics of dance movements. Through computer-aided perception of image systems, dance movements can be visually processed and presented more intuitively. This presentation method helps designers and audiences better understand and appreciate the beauty of dance movements.

Cultural heritage is the commonwealth of a nation, a region, and even all humanity, containing rich artistic, historical, philosophical, and scientific information. Dance, as an important component of cultural heritage, has a unique way of expression and profound cultural connotations. Yadaei et al. [15] explore how to create vocal expressions of dance movements based on melody and rhythm patterns in cultural heritage in order to better inherit and develop cultural heritage. Melody and rhythm are the soul of dance, determining the emotional expression and movement changes of dance. In cultural heritage, different ethnic groups and regions have their unique melodic and rhythmic patterns, which reflect the local customs, beliefs, and cultural traditions. Therefore, an in-depth study of these melody and rhythm patterns is of great significance for the creation and performance of dance. To conduct in-depth research on the melody and rhythm patterns in cultural heritage and understand their background, characteristics, and cultural connotations. By conducting field investigations and organizing literature, first-hand information is obtained to provide inspiration and a basis for subsequent dance creations. In dance creation, incorporating melody and rhythm patterns into dance movements makes the vocal expression of dance movements more distinct. For example, the melody and rhythm of local folk songs can be utilized to design corresponding dance movements, making dance performances more distinctive and ethnic. With the rapid development of the Internet of Things and wearable technology, dance image recognition has made significant progress. Among them, light motion capture technology, as a key means, provides strong support for the dynamic visualization simulation of dance. Zhang and Wang [16] discussed how to use dance image recognition technology based on IoT wearable devices to achieve dynamic visual simulation of light motion capture. Light motion capture technology is a technique that utilizes optical principles to accurately track and measure the motion of objects. In dance image recognition, light motion capture technology can track the body parts or marker points of dancers in real-time and obtain their motion trajectory and posture data. After processing, these data can be used to generate motion models for dancers and perform dynamic visualization simulations. Based on the motion data of dancers obtained through light motion capture technology, we can use computer graphics technology to achieve dynamic visualization simulation. This includes establishing a motion model for dancers, simulating the motion process, rendering scenes and special effects, etc. Through dynamic visualization simulation, we can observe and analyze the details and techniques of dance movements more intuitively, providing valuable feedback and guidance for dancers and choreographers.

3 RESEARCH METHODS AND DATA SOURCES

Dance arrangement, as the core link of dance creation, aims to organically combine individual dance movements into coherent and expressive dance works. Its basic principles mainly include the coherence of action, the coordination of rhythm, the use of space, and the expression of emotion. In terms of methods, choreography usually follows the step-by-step construction process from simple to complex, from single to multiple, and improves the structure and expressive force of works through constant trial and error and adjustment. Big data analysis refers to the process of collecting, sorting, mining, and analyzing massive, diverse, and rapidly changing data to reveal its internal laws and trends. Its core technologies include data acquisition and preprocessing, data storage and management, data mining and machine learning, data visualization, and so on. The comprehensive application of these technologies can effectively process and analyze large-scale data and provide a

scientific basis for decision-making. In the field of dance art, big data analysis technology has begun to show its edge. At the same time, capturing and analyzing the dancer's movement data is also helpful in optimizing the design and arrangement of dance movements.

CAD technology is a design method and technology using computers. In visualization, CAD technology can transform abstract design concepts into intuitive three-dimensional models or images so that designers can more clearly grasp the overall effect and details of design. In addition, CAD technology also supports dynamic display and interactive editing functions, which provides designers with more flexible design means. It has great potential to apply CAD technology to the field of dance art. Through CAD technology, choreographers can transform abstract dance movements and scenes into intuitive three-dimensional models or animations for preview and adjustment. At the same time, the interactive editing function of CAD technology can also realize the real-time modification and optimization of dance works and provide a more convenient and efficient workflow for dance creation. At present, some researchers and practitioners have begun to try to combine CAD technology with dance art and achieved certain results. This practical case proves the feasibility and broad prospect of combining CAD technology with dance art. However, there are still some shortcomings and gaps in the current research. First of all, in terms of big data analysis, the existing research mainly focuses on the stage of data collection and processing, and there is still a lack of in-depth research on how to deeply explore the inherent laws and trends of dance action data and how to apply these laws to dance choreography practice. Secondly, in the aspect of CAD visual presentation, the existing technology mainly focuses on static three-dimensional modelling and rendering, and there are still some technical bottlenecks in realizing dynamic display and real-time interaction of dance works. Finally, in terms of the combination of dance choreography with big data analysis and CAD visual presentation technology, the existing research still lacks a systematic theoretical framework and practical guidance, so it is difficult to effectively guide the innovative development of dance choreography practice. Therefore, this study aims to fill these gaps and provide new ideas and methods to support innovative development in the field of dance arrangement. Firstly, through quantitative analysis, this article makes statistics and analysis on a large number of data related to dance arrangements, big data analysis, and CAD visual presentation technology so as to reveal the internal relations and laws among the data. Specifically, the dance movement data and audience feedback data will be processed and analyzed by statistical methods to extract key information and features. At the same time, through qualitative analysis, the basic principles and methods of dance arrangement and the application of big data analysis technology and CAD visual presentation technology in the field of dance art are deeply discussed. By combing and analyzing the existing literature, this article summarizes the core concept and practical experience of dance choreography, as well as the specific application methods and effects of big data analysis and CAD technology in dance art.

The research data mainly come from the following aspects in Table 1:

Data source	*Specific content*
Open choreography database and dance action capture data set	It contains a large amount of dance movement data and related information, which provides a rich database for this article.
Audience feedback data on social media platforms	Including comments, likes, sharing, etc. These data can reflect the audience's preferences and attitudes towards dance works.
Related research literature and reports	It provides in-depth analysis and insights on dance arrangements, big data analysis, and CAD visual presentation technology.

Table 1: The source of the data studied.

To guarantee the authenticity and accuracy of the data, this article carefully selects authoritative and dependable data sources. Furthermore, the data undergoes multiple rounds of verification and

checking to maintain its integrity and consistency. Additionally, the article incorporates cutting-edge data processing techniques and methodologies to ensure a scientific and dependable data processing workflow and outcomes. These measures collectively ensure the high quality and reliability of the data.

4 CONSTRUCTION OF DANCE CHOREOGRAPHY MODEL BASED ON BIG DATA

In the stage of data analysis of dance movements, this study first digs into the massive data of dance movements. These data include dancers' motion capture data, video data of dance performances, and audience feedback data. Through careful analysis of these data, we can extract the key features and laws of dance movements. The characteristics of dance movements include the type, amplitude, speed, and rhythm of movements, while the rules are embodied in the combination of movements, transition skills, and emotional expression. The extraction of these characteristics and laws will help us to understand the essence and charm of dance movements more deeply and also provide strong data support for the subsequent dance arrangement. In dance performances, numerous steps require seamless coordination between the arms and legs to achieve their full expression. It's noteworthy that the coordination patterns between the limbs are not set in stone; they can vary. When extracting optical flow features, the technique can filter out background details that remain mostly unchanged in the image, allowing the focus to be primarily on the dancer's movements—whether it's their upper body, lower body, or full-body flows. Moreover, the motion capture device provides human joint coordinate data, enabling a more precise segmentation of the human body regions. This segmentation is illustrated in Figure 1.

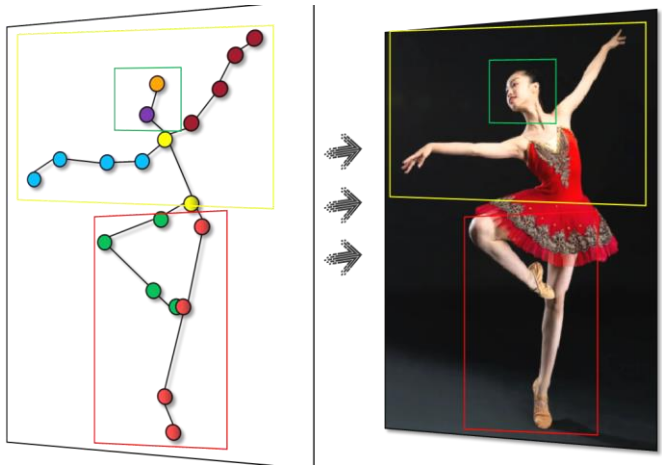

Figure 1: Dividing human body regions according to joints.

When building the human skeleton template, this article recognizes the variations in height and body shape among individuals. To guarantee precise and standardized comparison outcomes, the following standardized approach is employed:

$$P_c\ x,y\ = \left(\frac{sl_x + sr_x}{2}, \frac{sl_y + sr_y}{2} \right) \tag{1}$$

In this context, $P_c\ x,y\ $ it represents the designated centre point derived from the acquired bone points. Meanwhile, sl_x and sr_x denote the respective x coordinates of the bone points located on

the left and right shoulders, while sl_y, sr_y corresponds to the y coordinates. Subsequently, the deviations between the 20 bone points and the centre point are computed, leading to the acquisition of standardized human bone coordinate points with respect to the centre. Given that shoulder width varies from person to person yet exhibits a relatively consistent proportional relationship with an individual's height and body type, the distance between the shoulders serves as the basis for scaling the human skeleton coordinates to ensure standardization.

$$D_s = \sqrt{sl_x - sr_x^{\ 2} + sl_y - sr_y^{\ 2}} \tag{2}$$

In this context, D_s it represents the Euclidean distance spanning between the two shoulders. Following centre standardization, the x, y value about 20 bone points undergoes division D_s. This computational step enables the derivation of skeleton coordinates that align with a standardized scale, facilitating accurate matching.

After extracting the characteristics and laws of dance movements, the dance choreography model based on big data is constructed by using these analysis results. The model comprehensively considers the characteristics and laws of dance movements and the aesthetic preferences of the audience and automatically generates innovative and artistic dance choreography schemes through algorithms. In order to verify the validity and practicability of the model, a series of representative dance works are selected for experiments. By comparing the differences between the layout scheme generated by the model and the original works and inviting professional dancers and audiences to evaluate, the performance of the model is comprehensively evaluated. The results of audience feedback are shown in Figure 2.

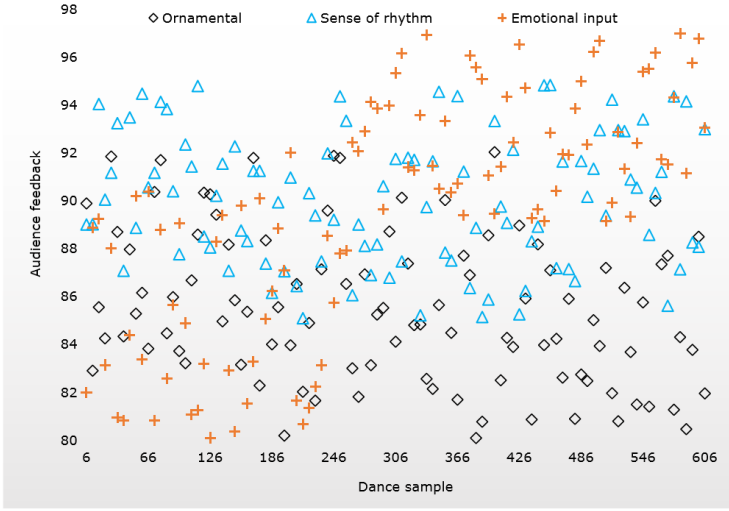

Figure 2: Audience feedback results.

It can be seen that most viewers are satisfied with the performance of the model. They think that the layout scheme generated by the model is not only ornamental but also can arouse the audience's resonance and emotional input. At the same time, the audience also evaluated the improvement of the model in layout efficiency and audience satisfaction, which is an important embodiment of the model's practicality. The expert evaluation results are shown in Figure 3.

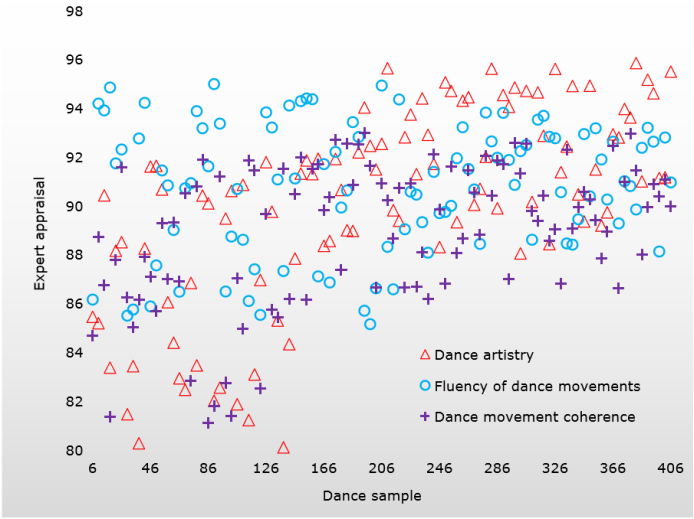

Figure 3: Expert evaluation results.

It can be seen that most experts gave positive comments on the performance of the model. They think that the choreography generated by the model not only maintains the artistic quality of dance but also pays attention to the fluency and coherence of dance movements, making the whole work more harmonious and unified. In addition, experts also pointed out that the model has a certain potential for innovation and can bring new ideas and inspiration to dance arrangements. Therefore, the model can be considered effective.

The research of dance choreography based on big data analysis in this article not only pays attention to the construction of the model but also puts forward specific dance choreography optimization strategies. These strategies will combine the results of big data analysis and practical experience in choreography to provide more scientific and systematic guidance for choreographers. According to the analysis of audience feedback data, we can understand the audience's preference for different types of dance movements so as to pay more attention to these popular elements in the arrangement process. In addition, by comparing the movement characteristics and laws of different dance works, we can also find some successful arrangement skills and patterns, which can be used as an important part of the optimization strategy.

5 VISUAL RENDERING ALGORITHM OF CAD

Before the CAD visualization of dance movements, it is necessary to choose the appropriate CAD visualization technology first. Considering the particularity and presentation requirements of dance movements, this article chooses those technologies that can support dynamic presentation, highly realistic rendering, and interactive operation. These technologies should have the ability to deal with complex three-dimensional models efficiently and can be seamlessly integrated with the dance choreography system to realize real-time data transmission and update. By comparing and analyzing the advantages and disadvantages of various CAD visualization technologies, the most suitable technical scheme for dance presentation is selected.

Using the selected CAD technology, the dance movement is modelled in three dimensions. This process includes transforming the dancer's motion capture data into a three-dimensional model and adding elements such as materials, maps, and lights to the model to enhance its visual effect. In the process of modelling, this article focuses on maintaining the fluency and naturalness of dance

movements while optimizing the structure and details of the model to improve the rendering efficiency. Assume that the size and direction of the 2D gradient of each pixel are:

$$m_2D\ x,y\ = \sqrt{L_x^2 + L_y^2} \tag{3}$$

$$\theta\ x,y\ = \tan^{-1}\left(\frac{L_y}{L_x}\right) \tag{4}$$

In this context, x,y it refers to the specific coordinate of a pixel within the image, while L_x, L_y it is derived through an approximation calculation utilizing finite differences. Subsequently, L_x, L_y they L_t are employed to determine the gradient magnitude and direction in 3D:

$$m_3D\ x,y,t\ = \sqrt{L_x^2 + L_y^2 + L_t^2} \tag{5}$$

$$\theta D\ x,y,t\ = \tan^{-1}\frac{L_y}{L_x} \tag{6}$$

$$\varphi\ x,y,t\ = \tan^{-1}\frac{L_t}{\sqrt{L_x^2 + L_y^2}} \tag{7}$$

Since $\sqrt{L_x^2 + L_y^2}$ it is positive, $\varphi\left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$ is consistently present, and every corner is uniquely identified by it θ,φ . Therefore, the gradient direction of every pixel in 3D is delineated by two distinct values. Within this article, the normalization of the 3D pose is undertaken, and the body joints are standardized in the following manner:

$$J_i^{'} = \frac{J_i - J_{neck}}{H_{nh}} \tag{8}$$

Among them, $J_i \in R^2$ is the position of body joints i , $J_i^{'}$ is the normalized position of J_i , J_{neck} is the position of neck, and H_{nh} is the distance between neck and hip. The dancer's gait contour points are divided, as shown in Figure 4.

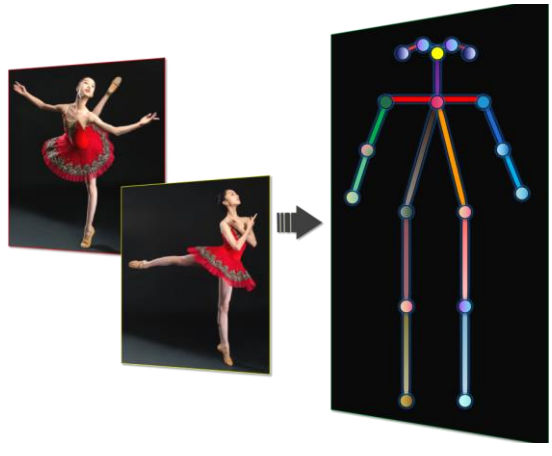

Figure 4: Division of gait contour points of dancers.

After the three-dimensional modelling is completed, the three-dimensional rendering and dynamic display of dance movements are carried out. Through efficient rendering algorithms and realistic lighting effects, the dance movements are presented to the audience vividly and realistically. At the same time, with the help of the dynamic display function of CAD technology, dance movements can be played, paused and replayed in real time, providing viewers with a richer viewing experience.

In order to realize the CAD visual presentation of dance movements, this article designs and implements a special algorithm. The algorithm will comprehensively consider the characteristics of dance movements, rendering efficiency and the aesthetic needs of the audience, and improve the visualization effect by optimizing the data structure and rendering process. Specifically, the algorithm includes data preprocessing, model construction, rendering optimization and other modules, and each module will adopt efficient and stable algorithms to realize its functions. During the implementation of the algorithm, we prioritize code readability and maintainability. Additionally, we embrace a modular design approach to enhance the system's scalability. After the algorithm is implemented, it is tested and evaluated comprehensively. By comparing the performance indexes and visual effects of different algorithms, the effectiveness and superiority of the designed algorithm can be verified. If the algorithm can meet the needs of the dance presentation and achieve the expected results, then it can be applied to the actual dance arrangement and visual presentation.

6 EMPIRICAL RESEARCH AND ANALYSIS

In order to verify the actual effect and application value of dance choreography and CAD visualization algorithm based on big data analysis, this article has carried out rigorous empirical research and design. Firstly, the purpose and problem of the research are clarified; that is, the performance of the algorithm in dance arrangement and visual presentation is evaluated. Then, select appropriate samples and data sources to ensure the representativeness and reliability of the data. On this basis, the scheme and implementation steps of empirical research are designed. The empirical research scheme mainly includes the following key steps: using big data analysis technology to deeply mine and analyze dance movement data and extract features and laws; Construct a dance choreography model based on big data and generate a choreography scheme; Using CAD visual rendering algorithm to model and render the arrangement scheme in three dimensions; Through audience feedback and expert evaluation, the arrangement scheme and visualization effect are evaluated.

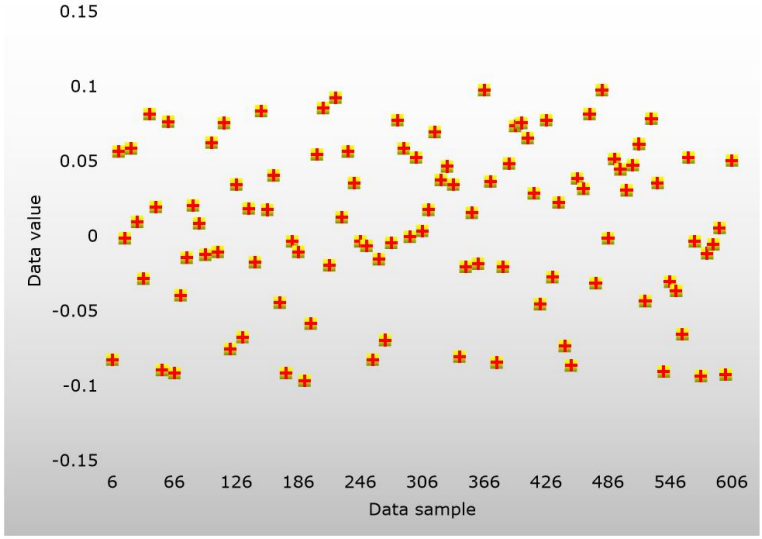

Figure 5: Data cleaning results.

In the process of empirical research, this article collects and analyzes data in strict accordance with the design scheme: (1) Collect multiple data such as dance action capture data, audience feedback data, and related research literature. In order to ensure the quality and reliability of the data, the data are cleaned, sorted, and preprocessed, and the noise and abnormal values are removed. The data cleaning result is shown in Figure 5.

Utilize statistical analytical techniques to conduct an in-depth exploration and evaluation of the data. By employing descriptive statistics, correlation analysis, regression analysis, and other methodologies, the underlying patterns and trends within dance movement data are uncovered and elucidated. At the same time, this article quantitatively evaluates the performance of CAD visual rendering algorithms, including rendering speed, image quality, and other indicators. The rendering speed of the algorithm is shown in Figure 6.

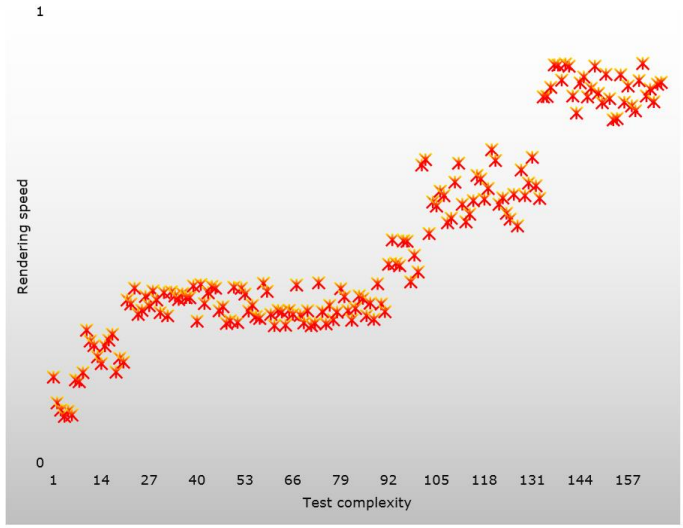

Figure 6: Rendering speed.

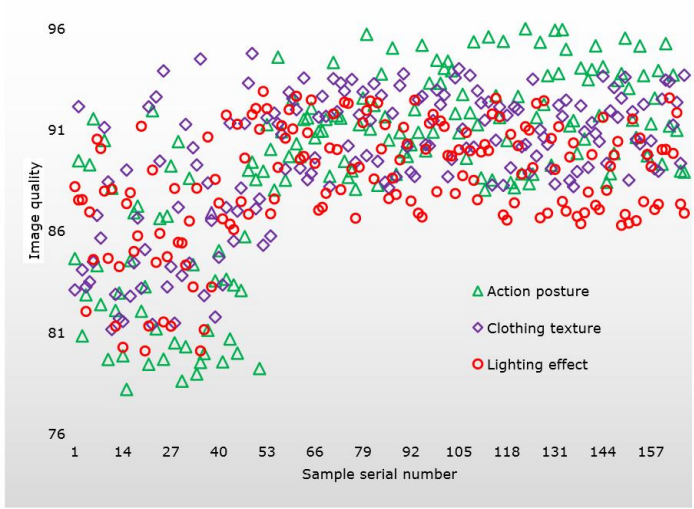

Figure 7: Image quality.

With the increase in test complexity, the rendering time shows a steady growth trend, but it remains in an acceptable range as a whole. This shows that the algorithm can still maintain a fast rendering speed when dealing with complex dance movements and meet the real-time or quasi-real-time visualization requirements. This performance is very important for dance teaching, rehearsal, and performance because it ensures the immediate feedback of action adjustment and improves work efficiency. The image quality generated by the algorithm is shown in Figure 7.

The image generated by the algorithm has a high degree of detail reduction and realistic texture representation. Whether it is the dancer's posture, the texture of the costume, or the light and shadow effect of the stage background, it has been accurately presented. This proves that the algorithm has high accuracy and reliability in image generation and can meet the visual requirements of a professional level.

Through empirical research and analysis, it is found that the dance choreography model based on big data analysis can effectively extract the characteristics and laws of dance movements and generate innovative and artistic choreography schemes. At the same time, the CAD visual rendering algorithm can realize the three-dimensional modelling and realistic rendering of dance movements and provide a more intuitive and vivid viewing experience for the audience. Audience feedback and expert evaluation show that the dance choreography scheme based on big data analysis and CAD visual presentation technology has high satisfaction and recognition. The above results not only verify the theoretical hypothesis and model construction of this study but also provide useful enlightenment for the field of dance arrangement and CAD visual presentation. In the future dance choreography practice, we can pay more attention to the concepts of data-driven and audience demand-oriented and use big data analysis and visualization technology to improve the scientificity and artistry of choreography. At the same time, CAD visual presentation technology also has broad application prospects in dance teaching, performance, and inheritance, which is worth further research and promotion.

7 CONCLUSIONS

Big data analysis technology plays a key role in the process of dance creation. This study deeply digs and analyzes the data of dance movements and successfully extracts the core characteristics and internal laws of dance, which provides a solid data cornerstone for dance arrangement. Based on this, this article constructs a big data-driven dance choreography model, which can generate creative and artistic choreography schemes, significantly improving choreography efficiency and audience appreciation experience. In addition, this article introduces CAD visualization technology, which opens up a new way for the three-dimensional simulation and rendering of dance movements. With the help of CAD tools, the accurate modelling and highly realistic rendering of dance movements are realized in this article so that the audience can appreciate the dynamic charm of dance more deeply. This innovation not only adds a new dimension to dance exhibitions but also brings unprecedented possibilities for dance education, stage performance, and artistic inheritance.

Although the research of this article has made remarkable progress, it still faces some challenges and limitations. For example, the complexity and diversity of dance movements mean that this study may not fully cover all dance types. Future research should be devoted to broadening the data sources and including more extensive dance movement data to enhance the universality and accuracy of the model.

Looking forward to the future, the research on dance choreography based on big data and CAD visualization technology can be further deepened in many aspects: perfecting the dance action database and optimizing data analysis methods, further improving the efficiency of big data-driven dance choreography model, expanding the application of CAD visualization technology in many fields of dance, and strengthening interdisciplinary cooperation to jointly promote the innovation and development of dance art.

8 ACKNOWLEDGEMENT

This paper is supported by the phased achievement of "Research on Digital Inheritance and Development of Hunan Traditional Dance National Intangible Cultural Heritage Project", a general project of the Hunan Philosophy and Social Science Foundation (No.: 21YBA198).

Lingmei Hu, https://orcid.org/0009-0000-8792-2013

REFERENCES

[1] Behrouzpour, B.-M.; Rezaei, F.; Fakherian, A.; Sekhavat, Y.-A.: Converting human movements into a conceptual painting based on music using a motion capture system: action research, Journal of Research in Rehabilitation Sciences, 15(2), 2019, 101-106. https://doi.org/10.22122/JRRS.V15I2.3471

[2] Bench, H.; Elswit, K.: Dance history and digital humanities meet at the archives: an interim project report on Dunham's data, Dance Research, 38(2), 2020, 289-295. https://doi.org/10.3366/drs.2020.0314

[3] Chen, Q.; Albarakati, A.; Gui, L.: Research on motion capture of dance training pose based on statistical analysis of mathematical similarity matching, Applied Mathematics and Nonlinear Sciences, 7(2), 2021, 127-138. https://doi.org/10.46719/dsa202029335

[4] Chen, Q.; Alsemmeari, R.-A.: Research on aerobics training posture motion capture based on mathematical similarity matching statistical analysis, Applied Mathematics and Nonlinear Sciences, 7(2), 2021, 203-216. https://doi.org/10.46719/dsa202029340

[5] Fan, C.; Fu, W.; Liu, S.: A high-precision correction method in non-rigid 3D motion poses reconstruction, Connection Science, 34(1), 2022, 2845-2859. https://doi.org/10.1080/09540091.2022.2151569

[6] Huang, H.; Zhu, H.: Application of image optical detection based on dynamic time warping algorithm in dance teaching, Optical and Quantum Electronics, 56(3), 2024, 287. https://doi.org/10.1007/s11082-023-05986-0

[7] Joshi, M.; Chakrabarty, S.: An extensive review of computational dance automation techniques and applications, Proceedings of the Royal Society A, 477(2251), 2021, 1-21. https://doi.org/10.1098/rspa.2021.0071

[8] Matsuyama, H.; Aoki, S.; Yonezawa, T.; Hiroi, K.; Kaji, K.; Kawaguchi, N.: Deep learning for ballroom dance recognition: A temporal and trajectory-aware classification model with three-dimensional pose estimation and wearable sensing, IEEE Sensors Journal, 21(22), 2021, 25437-25448. https://doi.org/10.1109/JSEN.2021.3098744

[9] Suandi, I.-N.; Bandem, I.-M.; Mudana, I.-W.; Partami, N.-L.; Aryanto, K.-Y.-E.: Delivering Balinese dance to the digital era: multimedia-enriched dictionary, Preservation, Digital Technology & Culture, 49(2), 2020, 59-65. https://doi.org/10.1515/pdtc-2020-0016

[10] Tan, B.; Yang, F.: Dance movement design based on computer three-dimensional auxiliary system, Computer-Aided Design and Applications, 19(S3), 2021, 108-118. https://doi.org/10.14733/cadaps.2022.S3.108-118

[11] Varela, M.-E.; Hernandez, B.-L.: Digital dance scholarship: Biomechanics and culturally situated dance analysis, Literary & linguistic computing, Journal of the Alliance of Digital Humanities Organizations, 35(1), 2020, 160-175. https://doi.org/10.1093/llc/fqy083

[12] Wang, S.; Tong, S.: Analysis of high-level dance movements under deep learning and internet of things, The Journal of Supercomputing, 78(12), 2022, 14294-14316. https://doi.org/10.1007/s11227-022-04454-y

[13] Wang, T.-J.: A study on utilizing 3D motion-capture analysis to assist in Chinese opera teaching, Research in Dance Education, 23(2), 2022, 194-222. https://doi.org/10.1080/14647893.2020.1812559

[14] Xu, X.; Zheng, J.: Evaluation of cultural creative product design based on computer-aided perceptual imagery system, Computer-aided Design and Applications, 19(S3), 2021, 142-152. https://doi.org/10.14733/cadaps.2022.S3.142-152

[15] Yadaei, A.; Azadehfar, M.-R.; Alizadehashrafi, B.: Creation of melodic and rhythmic patterns based on cultural heritage: sonification of Azerbaijani dance movements, Journal of Sound and Music in Games, 3(2-3), 2022, 1-27. https://doi.org/10.1525/jsmg.2022.3.2-3.1
[16] Zhang, Y.; Wang, Z.: Dynamic visualization simulation of light motion capture in dance image recognition based on IoT wearable devices, Optical and Quantum Electronics, 56(2), 2024, 141. https://doi.org/10.1007/s11082-023-05734-4