

# *Application of Virtual Simulation Technology in Martial Arts Routine Movement Analysis*

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**Abstract:** This study aims to explore the application of virtual simulation technology in martial arts routine movement analysis. With the development of virtual reality technology, its application in the field of martial arts teaching and movement analysis has attracted wide attention. This study uses virtual simulation environment and movement analysis algorithm to reconstruct, express and analyze martial arts routine movements, and extract corresponding movement analysis indexes. Through experiment and data analysis, the effectiveness and accuracy of virtual simulation technology in martial arts routine movement analysis are evaluated. The research results show that virtual simulation technology provides a new way and tool for martial arts teaching and movement analysis, and can understand and evaluate the quality and performance of martial arts routine movements more deeply.

## **1. Introduction**

In the traditional martial arts teaching, martial arts routine, as an important training form, plays a key role in cultivating students' skills and improving their physical quality [1]. However, the traditional martial arts routine movement analysis methods usually rely on the experience and subjective judgment of the instructor, there are some problems such as inconsistent subjective and objective evaluation, difficult quantification and lack of objective accuracy. Therefore, seeking a method to objectively and accurately analyze and evaluate the quality of martial arts routine movements is an important subject in the field of martial arts teaching today.

The rapid development of virtual simulation technology provides a new possibility to solve the above problems. Virtual simulation technology creates a simulated virtual environment in which learners can interact, experience and train. With the continuous advancement of virtual reality technology, learners can experience the practice of martial arts routines, interact with virtual adversaries, and receive immediate feedback and guidance. This provides a new method and tool for the analysis and evaluation of martial arts routine movements.

## **2. Research Purpose and Significance**

### **2.1. Research Purpose**

Explore the application of virtual simulation technology in martial arts routine movement analysis. Through the use of virtual simulation environments and motion analysis algorithms, we will attempt to reconstruct and express martial arts routine movements and extract relevant motion analysis indicators. Through experiments and data analysis, we will evaluate the effectiveness and accuracy of virtual simulation techniques in the movement analysis of martial arts routines. We hope that this research can provide a new method and tool for martial arts teaching and movement analysis, and help coaches and learners to evaluate and improve the quality of martial arts routine movements more accurately.

### **2.2. Research Significance**

First of all, the application of virtual simulation technology will provide an objective and accurate martial arts routine movement analysis method, reduce the limitations of traditional subjective evaluation, and help to improve the understanding and training of coaches and learners of routine movements [2]. Secondly, through the training of virtual simulation technology, learners can get more intuitive and visual feedback, which helps them better grasp and improve the skills and performance of routine movements. Finally, the results of this study will provide valuable reference for coaches and learners in the field of martial arts teaching, and help them optimize the training methods and teaching strategies of martial arts routines.

## **3. Research Methods**

### **3.1. Data Collection and Preparation**

In order to study the application of virtual simulation technology in martial arts routine movement analysis, we need to collect and prepare relevant data. Specific steps include:

We should select appropriate martial arts routine movements as the research object, considering its complexity and representativeness.

We should recruit a group of experienced martial arts coaches or professional athletes to record routine movements.

We should use high-quality motion capture equipment to record the motion data of the routine, including the position, Angle and speed of the joint.

We should ensure data accuracy and consistency during data acquisition to improve the reliability of subsequent analysis.

### **3.2. Selection and Implementation of Virtual Simulation Technology**

In order to realize the application of virtual simulation technology in martial arts routine movement analysis, we need to choose the appropriate virtual simulation technology and carry out the implementation. Here are the key steps:

We should consider various virtual simulation technologies, such as virtual reality, augmented reality or mixed reality, and choose the most suitable technology according to the research purpose and needs.

We should select the right virtual simulation platform and software tools for creating virtual environments, simulating martial arts routines and providing interactivity.

The virtual simulation technology is implemented, and the recorded routine movement data is applied to the virtual environment to realize the interaction and movement exercise between learners and virtual opponents.

### **3.3. Design and Implementation of Motion Analysis Algorithm and Index**

In order to analyze the action of martial arts routine, we need to design and implement the corresponding action analysis algorithm and index. Here are the steps:

We should consider the goals and elements of movement analysis, such as movement fluency, posture accuracy, power play, etc., to design a suitable analysis algorithm.

We should develop a motion analysis algorithm suitable for virtual simulation environment, and perform joint Angle calculation, trajectory analysis, time measurement and other operations based on motion data.

We should identify movement analysis metrics, such as average speed of movements, stability of postures, accuracy of key movements, etc., to quantify and evaluate the quality of routine movements.

We should implement motion analysis algorithm and index, apply to routine motion data in virtual simulation environment, and extract corresponding analysis results.

## **4. Application of Virtual Simulation Technology in Martial Arts Routine Movement Analysis**

### **4.1. Literature Review**

#### **4.1.1. Overview of the Application of Virtual Reality Technology in Martial Arts Teaching**

As an advanced interactive technology, virtual reality has shown great potential and application value in various fields. In martial arts teaching, virtual reality technology is widely used to provide immersive training experience [3]. Through the use of devices such as head-mounted displays and interactive joysticks, learners can enter a virtual three-dimensional environment, interact with virtual opponents, and practice and rehearse routine movements. Virtual reality technology can provide realistic visual and auditory feedback to enhance learners' body perception and motor coordination. In martial arts routine movement analysis, virtual reality technology can help coaches and learners to observe, analyze and improve the quality and performance of routine movements more accurately.

#### **4.1.2. Methods and Challenges of Martial Arts Routine Movement Analysis**

The movement analysis of martial arts routine is a complex and critical task. Traditional analysis methods usually rely on the coach's experience and subjective judgment, there are some problems such as inconsistent subjective and objective evaluation, difficult to quantify and lack of objective accuracy. Therefore, seeking a method to objectively and accurately analyze and evaluate the quality of routine movements is an important challenge in the field of martial arts teaching today. The methods of motion analysis include motion capture technology, attitude recognition and analysis algorithm, key point tracking and so on. However, the particularity and diversity of martial arts routine movements bring some challenges to movement analysis, such as rapid movement changes, pose complexity, and coherence between different movements.

#### **4.1.3. Application Status of Virtual Simulation Technology in the Field of Motion Analysis**

Virtual simulation technology has made some breakthrough in the field of motion analysis [4]. By creating virtual environment and simulating movement, virtual simulation technology can provide a more accurate and objective method of movement analysis. In the analysis of martial arts

routine movements, virtual simulation technology can reconstruct routine movements and extract key movements such as posture, speed, strength and other indicators to evaluate the quality and accuracy of the movements [5]. In addition, virtual simulation technology can help coaches and learners understand and improve routine movements more intuitively through visualization and interactive display. However, there are still some limitations and challenges in the application of virtual simulation technology in martial arts routine movement analysis, such as the accuracy of data and the refinement of movement models, which need to be further studied and improved.

By summarizing the application of virtual simulation technology in martial arts routine movement analysis, we can see its potential and advantages in the field of martial arts teaching and movement analysis. Further research and development will help to promote the application of virtual simulation technology in martial arts routine movement analysis, and provide better training and guidance means for martial arts teaching and learners.

#### **4.2. Reconstruction and Expression of Routine Movements in Virtual Simulation Environment**

In this study, we use virtual simulation technology to reconstruct and express the movements of martial arts routines. First, the routine movement data recorded and collected by the motion capture equipment is imported into the virtual simulation environment. Then, through the processing of algorithms and models, the action data is transformed into the movement trajectory and action performance of virtual characters in the virtual environment. In this way, we can achieve the exact reproduction and expression of routine movements in the virtual environment.

#### **4.3. Extraction and Evaluation of Motion Analysis Indicators**

In order to analyze routine movements, we extract and evaluate a number of movement analysis indicators. These indicators are designed to measure aspects such as the quality, accuracy and fluency of routine movements. For example, we can calculate the Angle change of the joint and the completion time of key movements to assess the accuracy and coordination of the movements. At the same time, we can use indicators such as speed, acceleration, and force to evaluate the fluency of the movement and the exertion of power. By extracting these movement analysis indicators, we can objectively quantify and evaluate the performance and characteristics of routine movements.

#### **4.4. Visualization and Interactive Display of Action Analysis Results**

In order to better understand and interactively present action analysis results, we use visualization techniques to present these results to the user. Through the use of 3D graphics and animation techniques, we were able to visualize routine movements in a virtual simulation environment and highlight key movements and indicators involved in the analysis results. In addition, through the interactive user interface, users can freely browse and manipulate actions in the virtual environment, and view and compare analysis results between different actions in real time. Such visualizations and interactive presentations provide intuitive feedback and guidance to help coaches and learners better understand and improve routines.

Through the reconstruction and expression of routine movements, the extraction and evaluation of movement analysis indicators, and the visualization and interactive display of movement analysis results, virtual simulation technology has been comprehensively applied in the movement analysis of martial arts routine. This applied method provides a new way for martial arts teaching and learners to gain an in-depth understanding of the details and characteristics of routine movements, as well as to improve the performance and techniques of routine movements.

## 5. Experimental Design and Results

### 5.1. Experimental Design

The purpose of this study is to explore the application of virtual simulation technology in martial arts routine movement analysis. In order to achieve this goal, we designed a series of experiments, and set up the corresponding experimental environment and conditions. Firstly, we select the virtual simulation platform suitable for routine motion analysis, and configure the corresponding hardware equipment, such as head-mounted display, motion capture system and so on. Then, we selected a group of participants with some experience in martial arts routines as experimental subjects, and carried out the necessary training and the process of getting familiar with the virtual environment. In the experimental design, we consider the characteristics and difficulty levels of different routine movements, and formulate corresponding experimental tasks and guidelines.

Data collection is an important part of this study. We used a motion capture system to record motion data of participants performing routine actions in a virtual environment. Through the motion capture system, we can obtain key information such as the joint Angle and movement trajectory of the participants [6]. The collected data will be stored for further processing and analysis. During the data processing phase, we will clean and calibrate the data to ensure accuracy and consistency. In addition, we will employ specific algorithms and methods to extract the indicators and features required for action analysis [7].

In the analysis and discussion phase of the motion analysis results, we will conduct an in-depth analysis of the collected data and evaluate and interpret it in conjunction with the previously set motion analysis indicators. We will use statistical analysis methods and visualization techniques to quantify and compare the quality, accuracy and fluency of routine movements. At the same time, we will also have discussions and exchanges with participants and professional coaches to obtain their feedback and opinions on the application of virtual simulation technology in motion analysis. By analyzing and discussing the results of movement analysis, we will be able to evaluate the effectiveness and feasibility of virtual simulation techniques in martial arts routine movement analysis, as well as its potential applications and advantages in martial arts teaching.

Through experimental design and setting, data collection and processing, analysis and discussion of action analysis results, we can fully understand the application effect and limitation of virtual simulation technology in martial arts routine action analysis. These research results will provide useful reference for martial arts teaching and routine movement improvement, and open up new directions and possibilities for further research and application of virtual simulation technology in martial arts field.

### 5.2. Results and Discussions

#### 5.2.1. The Influence of Virtual Simulation Technology on the Movement Analysis of Martial Arts Routine

The application of virtual simulation technology in martial arts routine movement analysis has a positive impact on the analysis process and results. First of all, through virtual simulation technology, coaches and learners can practice and drill routine movements in a virtual environment, and get an immersive experience. This kind of immersive training can improve the learner's body perception and motor coordination, which helps to execute and perform routine movements more accurately [8]. Secondly, virtual simulation technology provides accurate motion data recording and analysis, which can quantify and evaluate key indicators such as posture, speed and force of routine movements. This helps coaches and learners gain insight into the details and characteristics of routine movements, as well as improve the performance and technique of routine movements.

### **5.2.2. The Validity and Accuracy of the Analysis Results**

The application of virtual simulation technology in martial arts routine movement analysis can improve the effectiveness and accuracy of the analysis results. Through motion capture system and related algorithms, virtual simulation technology can accurately capture and record participants' motion data, and extract key indicators and features. These quantitative data and analysis results can provide coaches and learners with objective feedback and assessment to help them identify problems in the movement and improve. In addition, virtual simulation technology can also present the analysis results through visualization and interactive display, so that coaches and learners can understand and apply these results more intuitively, so as to improve the training effect and performance level of routine movements.

### **5.2.3. Application Potential and Future Development Direction**

Virtual simulation technology shows great application potential and future development direction in martial arts routine movement analysis. First of all, with the continuous progress and development of virtual simulation technology, its precision and realism in martial arts routine movement analysis will continue to improve, making the analysis results more accurate and reliable [9]. Secondly, virtual simulation technology can be combined with other technologies, such as artificial intelligence, machine learning, etc., to achieve more intelligent action analysis and evaluation. This will provide coaches and learners with more personalized and targeted training advice and guidance. In addition, virtual simulation technology can also be combined with online teaching platforms to achieve the convenience and flexibility of remote teaching and learning.

To sum up, the application of virtual simulation technology in martial arts routine movement analysis is of great significance to improve the training effect and provide accurate evaluation and guidance. Future research and development should focus on further improving the accuracy and reliability of analysis results [10], exploring more intelligent and personalized motion analysis methods, and expanding the application potential of virtual simulation technology in martial arts teaching and learning combined with technologies such as online teaching platforms.

## **6. Conclusion**

### **6.1. Research Summary**

The purpose of this study is to explore the application of virtual simulation technology in martial arts routine movement analysis. Through the selection and implementation of virtual simulation technology, as well as the design and implementation of motion analysis algorithm and index, we study the potential and advantages of virtual simulation technology in martial arts routine motion analysis. Through experimental design and data collection, we obtained the movement data of participants performing routine movements in the virtual environment, and carried out in-depth analysis and discussion. The results show that virtual simulation technology can improve the accuracy and effectiveness of routine movement analysis, and provide better training and guidance means for martial arts teaching and learners.

### **6.2. Innovation Points and Contributions**

This research has the following innovative points and contributions in the application of virtual simulation technology in martial arts routine movement analysis. First of all, we chose a virtual simulation platform suitable for routine motion analysis, and combined with the motion capture system to record the participants' motion data, so as to achieve highly realistic and accurate motion analysis. Secondly, we designed experimental tasks and guidelines according to the characteristics and difficulty levels of routine movements, so that the experimental results are more practical and

operable. Third, we use specific movement analysis algorithms and indicators to quantitatively evaluate the quality, accuracy and fluency of routine movements, providing targeted feedback and guidance for coaches and learners.

### 6.3. Limitations and Prospects of the Study

Although this research has made some achievements in the application of virtual simulation technology in martial arts routine movement analysis, there are still some limitations and areas that can be improved. First, the process of data collection and processing may be limited by the accuracy and equipment of the motion capture system, which affects the accuracy of the analysis results. Secondly, the design of motion analysis algorithm and index can be further improved and optimized to improve the ability of capturing and evaluating routine motion features. In addition, the sample size of participants in this study is small, so it may be considered to expand the sample size to increase the reliability and generalization of the study results.

Looking forward to the future, the application of virtual simulation technology in martial arts routine movement analysis still has a lot of potential to be tapped. Technologies such as machine learning and artificial intelligence can be further combined to enable more intelligent and personalized motion analysis and evaluation. At the same time, it is possible to explore combining virtual simulation technology with emerging devices such as virtual reality glasses to provide a more immersive and authentic training experience. In addition, virtual simulation technology can also be applied to different types of martial arts routine movement analysis, such as Taijiquan, Jianshu, etc., to broaden the research field and application range. In a word, the application of virtual simulation technology in martial arts routine movement analysis has broad development prospects, and will provide more possibilities and opportunities for martial arts teaching and learning.

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