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Research article

Practical application of interactive AI technology based on visual analysis in professional system of physical education in universities

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ABSTRACT

Currently, physical education teaching in universities tends to adopt the traditional model of one teacher for multiple students, which has high requirements for teachers and is difficult to consider students' strengths. On this basis, an interactive system has been established, including three modules: behavior information, user data collection, and behavior evaluation. Taking the 400 m running physical education teaching as an example, Kinectv2 was used to collect students' movements and contours while running, and ORB (Oriented FAST and Rotated BRIEF) feature extraction algorithm was used to extract students' movement features. After importing the data into the interactive system, students and teachers could view it in the system and provide guidance based on the students' actions. This article took 10 students as examples to test their performance changes in the 400 m running before and after systematic training. The results showed that the evaluation score after receiving systematic instruction increased by 6–7 s compared to the score without receiving instruction, with a significant change. This indicated that the interactive AI (artificial intelligence) system constructed in this article can play a significant role in sports teaching of 400 m running.

1. Introduction

With the continuous deepening of educational reform, computer technology and its applications are constantly developing. The traditional physical education teaching model is no longer suitable for the needs of higher education in today's society. Due to the constraints of time and space, educational resources have been wasted to some extent. Traditional physical education teaching usually adopts a centralized teaching method, where one teacher conducts group teaching for multiple students. The traditional physical education teaching model usually involves large class teaching, where teachers impart physical education knowledge and skills to students through demonstrations, explanations, and other methods. Information technology, especially interactive AI technology, has penetrated into every field of today's society. The emergence of interactive AI technology has made teaching more diverse, while solving the problem of a shortage of professional teachers, which can bring huge development space to the optimization and sharing of educational resources. Interactive teaching can continuously enhance students' learning initiative and interest, which can fully

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stimulate their potential to acquire new knowledge and technologies, and greatly cultivate their innovative consciousness. Meanwhile, building a learning module can continuously enhance the personal qualities of teachers, and help them pursue their professional development and improve their education and teaching level, thus enhancing the interaction between teachers and students.

At present, physical education in universities is mostly offline teaching, which is basically a traditional model of teacher's demonstration and student's learning [1]. Some researchers have found that traditional physical education teaching has problems such as singularity, lack of integrity or practicality. However, their solutions mainly revolve around offline incentives and improving offline teaching methods [2,3]. For example, Yuan [4] believed that schools should provide moral education in various disciplines, especially in physical education teaching. School physical education not only enhances students' physical fitness and skills, but also cultivates and develops their ideological and moral qualities in physical education teaching. Vasconcellos et al. [5] thought that teachers have a greater impact on classroom experiences of autonomy and abilities, and the relevance of physical education is related to the influence of peers and teachers. Therefore, he advocated strengthening the training of physical education teachers. Karasievych et al. [6] aimed to validate newly created or updated teaching conditions through experiments to train future physical education teachers in physical education and sports activities in secondary schools, demonstrating the need to establish an effective system for training athletes, which was the foundation for ensuring higher achievements in sports. Beni et al. [7] studied how teachers can promote the significance of physical education by providing guidance and starting to develop a specific teaching strategy for coherent physical education practice methods. It can be clearly seen that these studies have a certain effect on improving physical education performance, but they have not deviated from the original teaching framework and still rely on teachers to teach students, with a high demand for good teachers.

This article aims to improve students' physical education performance through interactive AI technology, which has long been applied in teaching and has achieved excellent results in multiple courses. For instance, Jiang [8] used an interactive electronic whiteboard to carry out situational teaching of Chinese in primary schools, creating interactive teaching situations and improving students' Chinese literacy. Wang [9] used interactive "all-in-one machines" to allow students to experience perception activities of specific area sizes, and combined examples to form an experience of the meaning of area. In teaching, the original static learning content is presented in the form of dynamic generation in front of students, creating a platform for independent exploration, communication, and cooperation. Cheng and Tsai [10] conducted immersive VR teaching and explored teacher-student interaction behavior in learning activities. His results indicated that students' motivation was generally enhanced, especially in reducing exam anxiety. Some researchers also used interactive technology in physical education teaching. The research of Yang et al. [11] results showed that the number of mobile learning in the sports field is increasing year by year, and the integration of new mobile technology into sports activities is becoming more and more common. Goad et al. [12] argued that online sports presents a series of unique challenges in transforming traditional face-to-face courses into digital spaces. These physical education educators with learning experience must be proficient in online teaching methods and the use of support technologies. It can be found that combining interactive intelligent devices with physical education teaching is the direction of future physical education development.

Interactive teaching systems are currently less widely used due to reasons such as funding, manpower, technology, and recognition. However, with the increasing generalization of education, establishing such an education system has gradually become a trend and a contradiction that must be addressed. In this paper, Kinect motion capture device is used to capture the posture of students when they run. By constructing an interactive system for analyzing actions, students can identify their shortcomings while running, thereby enhancing their learning initiative and interest. This fully mobilizes their potential to acquire new knowledge and technology, vigorously cultivates their innovative consciousness, and thus achieves the effect of improving their performance. By using devices such as Kinectv2, the system collected movement data of students during a 400 m run. These data may include information such as the student's posture and movement trajectory. Visualizing these data can enable teachers and students to have a clear understanding of the execution of actions, thereby better identifying problems and making improvements. By building an interactive system and importing action data into the system, students and teachers can interact in real-time within the system. This interactive process can be achieved through a visual interface, helping users understand data and interaction results more clearly, and improving the user experience. Through a visual interface, real-time interaction between teachers and students is achieved, improving teaching effectiveness and learning initiative.

2. Data collection and system construction

2.1. Motion data collection

In the process of establishing an interactive teaching system based physical education teaching classroom, firstly, the problem of low teaching efficiency under conventional teaching modes is solved. More importantly, establishing an interactive teaching process can provide teachers and students with a more comprehensive information-based teaching and learning space, promoting the maximization of the benefits of information based teaching.

With the comprehensive application of new generation information technologies such as the Internet of Things (IoT), cloud computing, big data, virtual reality (VR), and AI in the field of teaching, the emergence of intelligent classrooms and interactive classrooms not only enables teachers to create more constructivist cognitive contexts, but also further enhances interactive communication between teachers and students. Teachers can more conveniently guide students to carry out independent learning or collaborative learning and inquiry activities. Students can also make full use of the networked and intelligent learning environment to actively participate in learning interaction and timely feedback, so as to efficiently complete the active construction of knowledge meaning.

Taking 400 m running as an example, it is completed through three stages: pre preparation (venue construction, athlete preparation, etc.), real-time sports collection, and data output. After collecting action data, data for each action can be obtained, as well as the spatial coordinates of the marked points for recording each action in the body.

In the example of 400 m physical education teaching, Kinectv2 technology was used to collect the movements and contours of students while running. Kinectv2 is a somatosensory technology with depth sensing and motion capture capabilities, which can be used to monitor and capture the posture and movements of the human body in real-time during movement.

The motion capture experiment selects the movements of the students from the start to the end, and arranges Kinect motion capture equipment in the sports place. The acquisition environment has a camera in the experimental place [13], as shown in Fig. 1.

After preparation, students stand in the set sampling area and follow the pre set operating steps to collect all data in real-time. Kinect motion capture device records the positions of each node on the inheritor, and then uses it for subsequent data analysis and processing. Kinect's camera can capture color images within a certain field of view, with v1 and v2 resolutions of 640x480 and 1920x1080, respectively. Kinect can be used to obtain users' deep information. The detectable effective range of Kinectv1 is 0.8m–4.0 m, and the detectable effective range of Kinectv2 is 0.5m–4.5 m. If the user is within the valid range, Kinect can detect his presence. Kinect can track the location information of 6 users. Kinectv1 can track the detailed position information of two users in real-time, including detailed pose and three-dimensional (3D) coordinate information of bone points. Kinectv1 can support up to 20 bone points, and Kinectv2 can support up to 25 bone points. In this article, Kinectv2 is used for action image acquisition. The nodes collected by Kinectv2 are shown in Fig. 2.

Body sensing technology is a type of human-computer interaction technology, also known as body sensing interaction technology. Sensory technology can directly interact with corresponding sensory devices through body language, speech, eye movements, and other means. It is a human-computer interaction technology where a specific machine completes user action recognition, analysis, and feedback [14,15]. It emphasizes a behavior that utilizes daily actions, gestures, and speech to interact with computers, without relying on non natural control methods such as mice and keyboards. These advantages make body sensing interaction technology stand out among numerous natural human-computer interaction technologies.

Kinect body sensing technology has the characteristics of availability (software's and hardware's advantages) and strong interactivity, which can maintain rich interactivity. Through innovative forms and interesting gameplay designs, it meets the visual needs of learners and effectively improves teaching effectiveness. Kinect can collect exercise information from trainers, enabling real-time communication and interaction with them. Because there are significant differences in cognitive understanding and learning abilities among individuals during the learning process, it is necessary to develop special learning content targeting to each individual's learning situation. The Exercise information from trainers using Kinect is shown in Fig. 3.

Kinect can demonstrate different uses based on the different roles it plays in the teaching process.

(1) As a teaching tool, it can enhance users' immersion in learning, break traditional teaching models, and help professors and learners establish a correlation between body language and knowledge content, thereby achieving the goal of learning in activities.
(2) It can also be used as teaching content, as a body sensing game developed with teaching as the goal. These games, such as sports games and number games, can be directly used as teaching content, with intuitive learning effects, allowing students to further think about the application of the knowledge they have learned in real life.
(3) In terms of teaching context, body sensing technology is an external condition in teaching activities, which can encourage students to actively learn and participate in teaching activities. In the actual teaching process, the most headache for teachers is probably how to stimulate students' learning enthusiasm and persistence, which Kinect has effectively solved.

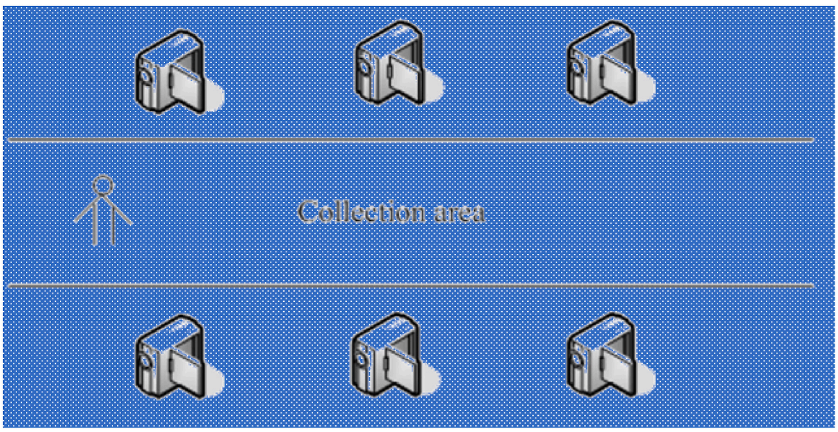

Fig. 1. Motion collection.

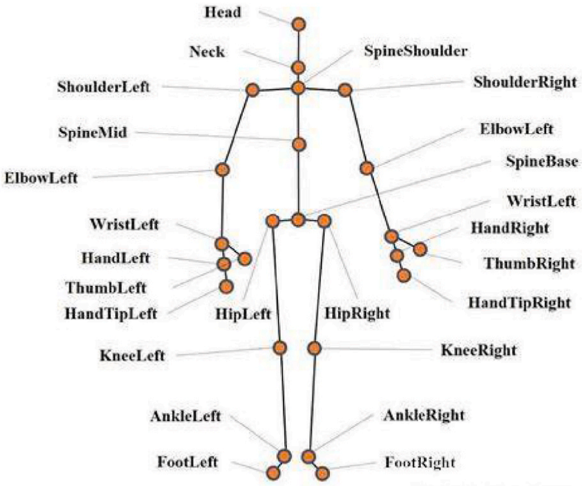

Fig. 2. Collected nodes.

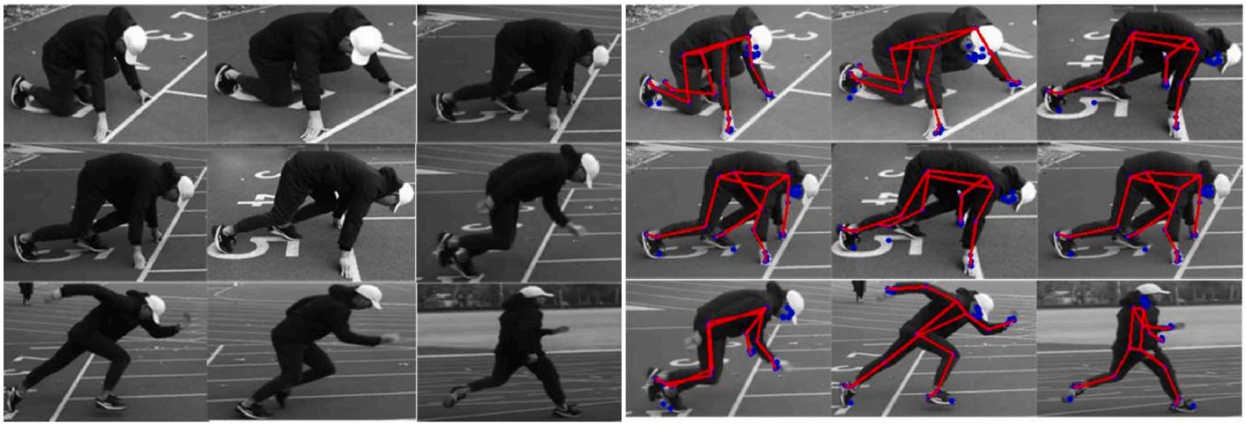

Fig. 3. Exercise information from trainers using Kinect.

2.2. ORB feature extraction

The paper used Kinectv2 and other devices to collect movement data of students during their 400 m run. The application of AI technology involves aspects such as motion recognition and posture analysis. Through data analysis, the system can understand the movement characteristics of students and apply them to subsequent interactive teaching. It used ORB algorithm to extract features of student actions. The ORB algorithm combines the feature extraction and description algorithms of FAST and BRIEF, and has the characteristics of rotation invariance. The application of AI technology can detect feature points, generate descriptors, and so on.

In the interactive system, the ORB feature extraction algorithm is used to extract student action features. ORB is a feature extraction and description algorithm that combines FAST and BRIEF.

FAST (features from accelerated segment test) algorithm can quickly filter out corner points with significant differences from surrounding pixels, but these corner points do not have orientation information. When the image rotates, subsequent descriptors can change accordingly, losing the uniqueness of feature points and causing many incorrect pairing [16]. ORB algorithm consists of two parts, oFAST (Oriented FAST) feature point detection and rBRIEF (rotated BRIEF) feature point description. The former method is based on FAST images and uses the feature extraction method of FAST images to solve the problems of lack of rotation invariance and scale invariance of feature points in FAST images. The latter is based on BRIEF, which enhances the anti noise ability of descriptors and improves their discriminative power [17]. Overall, the ORB feature extraction algorithm is easy to implement and has high performance, demonstrating its unique advantages in most application scenarios [18,19].

ORB algorithm adds directional attributes to the feature points of FAST and determines the main orientation of each feature point through the grayscale center of gravity method. The grayscale centroid method assumes that the grayscale of a feature point deviates from the center of gravity of the feature point domain, and then calculates the main direction of the feature point based on the vector that points to the center of gravity [20,21]:

Given a point $x = (x, y)$ in an image I, and the neighborhood moments is defined by equation (1). where M_{xy} neighborhood moments, $I(x, y)$ is the image I in point $X = (x, y)$.

$$M_{xy} = \sum p^x q^y I(x, y) \tag{1}$$

Eq. (1) The neighborhood moments calculation formula.

ORB algorithm efficiently describes feature points in the form of binary strings. Assuming the existence of a smooth image, criterion ε in the neighborhood P of size M ∗ M can be defined by equation (2).Where p(x) is the gray level at the area x around the image feature point [22].

$$\varepsilon(p; x, y) = \begin{cases} 1 : I(p, x) < I(p, y) \\ 0 : I(p, x) \geq I(p, y) \end{cases} \tag{2}$$

Eq. (2) Formula for calculating the criterion in the neighborhood P of size.

ORB algorithm is an improvement on BRIEF. It first randomly generates a pair of point pairs in the adjacent area of 31 × 31 of feature points. During recognition, the pixels and sizes in the area of 5 × 5 are compared with the two points of the pair as the center. The values of $I(p, x)$ and $I(p, y)$ are compared by equation (2). If the size is large, 1 is obtained, and if the size is small, 0 is obtained, which perform binary encoding and improve the noise resistance of the descriptor.

The matrix of 2 × n is used to represent the n pairs of point sets in neighborhood area of 31 × 31 of feature point. To attain a description of n bits, n matching pairs of pixel points need to be selected [21]. For example, a 2 × n matrix D can be defined by using equation (3).

$$D = \begin{cases} x_1, \ldots, x_n \\ y_1, \ldots, y_n \end{cases} \tag{3}$$

Eq. (3) Formula for calculating the n pairs of point sets in neighborhood area.

In equation (4), the main direction angle of the feature point calculated by oFAST is γ, and the rotation matrix R_γ is derived from this angle.

$$R_\gamma = \begin{bmatrix} \cos\gamma - \sin\gamma \\ \sin\gamma \quad \cos\gamma \end{bmatrix} \tag{4}$$

Eq. (4) The calculation formula of the rotation matrix.

The size of point pairs represented by equation (3) is compared to form a binary string rotation descriptor [22]. ORB algorithm is used to extract the features of the student's posture when starting, as shown in Fig. 4.

In ORB algorithm, machine learning is often used to find the optimal solution. In addition, some detected local corners are highly likely to gather together, resulting in "clustering" phenomenon, which not only wastes image expression resources, but also has adverse effects on subsequent image matching and can cause misoperation. In short, the principle is as described in equations (1)–(4) above: To calculate the response size of each feature point, and then retain the feature points with larger response values within the adjacent range. Combining the optimal FAST signal detection method with the BRIEF descriptor can achieve results of up to two orders of magnitude higher than SIFT (Scale Invariant Feature Transform), SURF (Speeded Up Robust Features), and others. ORB algorithm has higher speed and less storage space.

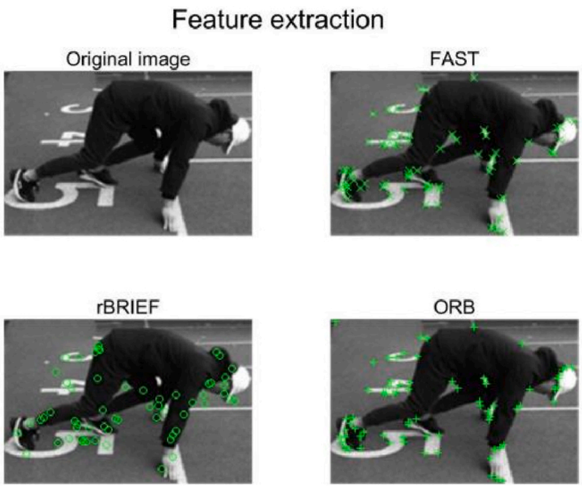

Fig. 4. ORB feature extraction.

2.3. Construction of interactive systems

An interactive AI physical education teaching system is constructed. The system collects information on 400 m running movements and standard movements, providing convenient and unrestricted teaching services for students. With the help of this system, students can easily view the action information of 400 m running, and can also learn and objectively evaluate the action.

The data of the action information database mainly comes from the metadata of the 400 m running. Among them, the main title is regarded as an entity in the conceptual model design of the action information database, and its subtitle is regarded as an attribute in the conceptual model design of the action information database. Its attribute fields are determined. The design system automatically generates a data table and fully enters the collected data into the standard table. When the details of the operation can be seen, the interface can be displayed from the operation information database.

The system includes modules such as action information, user data collection, and learning action evaluation. In the learning action evaluation module, its main function is to evaluate the learning results and compare the similarity between user actions and template actions. Users can observe and compare the differences to discover their own shortcomings in action learning, and view them from scratch to improve them.

Among them, the design of the database is a very crucial link, which is the basis for the entire system design and can effectively ensure the efficient operation of the system. The system uses relational database to manage structured data, achieving the purpose of unified data storage, network sharing and distributed processing.

In real behavior learning, the path of behavior learning is often a combination of multiple behavior states, but current video behavior learning often completes a series of behavior states in one go. Collecting user learning information can provide a more detailed division of the user's learning path. The original learning path is divided into branch actions based on their criticality, and each branch action is further divided into several teaching segments. When each branch action experiences continuous errors or requires enhanced practice, users can personalized learn it according to their own needs, either by dividing it into two fragmented actions or three fragmented actions, in order to learn more refined fragmented actions. The constructed system is shown in Fig. 5.

In traditional classroom teaching, teachers generally use methods such as walking around, asking questions, or asking students to raise their hands to understand their learning completion. However, in physical education teaching, teachers cannot fully understand the problems of each student, and subsequent evaluation and explanation may not be targeted, which reduces classroom efficiency. The interactive AI teaching system used in this plan not only effectively solves this problem, but also allows students and teachers to conduct targeted learning and training in the system.

The interactive system provides a graphical user interface, through which students and teachers can intuitively view information such as student movement data, action trajectories, and evaluation results. During the exercise process, the system may provide real-time feedback, displaying the student's current movement status, posture, or other key information. This helps students adjust their movements and improve their skills in a timely manner during sports.

The interactive system for physical education teaching includes three main modules: behavior information module, user data collection module and behavior evaluation module.

Behavior Information Module: this module mainly involves collecting information on the behavior and actions of students during exercise. In this study, devices such as Kinectv2 were used to capture movements of students during a 400 m run. This module collects the movement data of students in real time through sensors or other devices, including movement, posture, contour and other information.

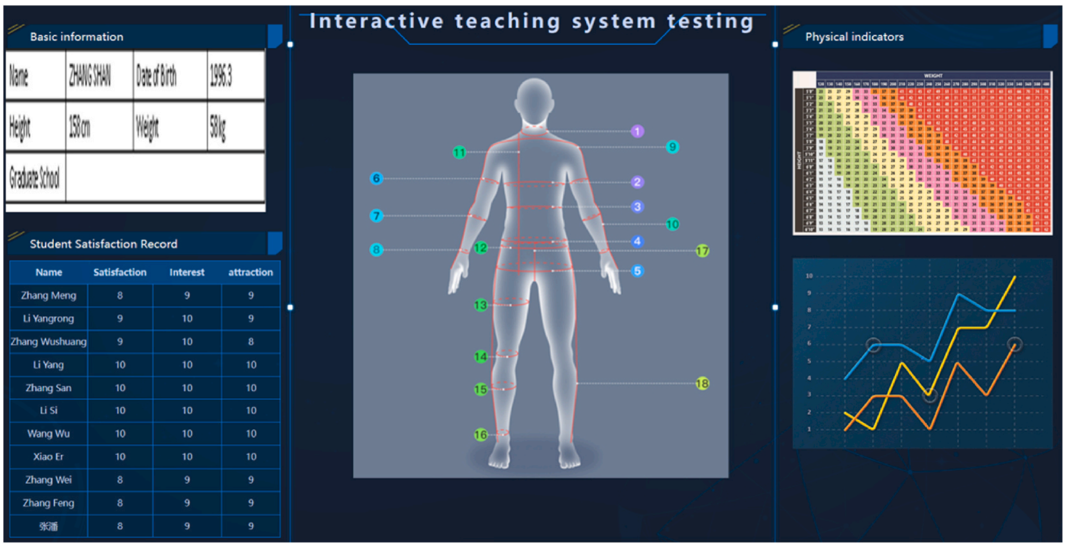

Fig. 5. Main interface of the system.

User Data Collection Module: this module is responsible for collecting individual data related to students to better understand their personalized characteristics and learning status. It may involve the basic information, sports history, learning preferences, etc., of the trainees. These data contribute to personalized instructional design and evaluation of student learning progress.

Behavior evaluation module: this module is used to evaluate and analyze the exercise behavior of students. In this study, the ORB feature extraction algorithm was used to extract the action features of the trainees. By analyzing the movement characteristics of students, the system can identify their shortcomings and provide a basis for personalized teaching. The goal of this module is to provide targeted teaching and improvement suggestions according to the performance of the trainees.

The three modules together form a comprehensive interactive system, enabling real-time interaction and feedback between students and teachers in a virtual environment. By integrating these modules, the system helps to improve the personalized level of physical education teaching, making learning more interesting and effective, and promoting student progress through data-driven methods.

3. Experiment and analysis

3.1. System demonstration

The interactive real-time remote teaching system consists of terminal devices, switching devices, camera systems, high-speed data communication networks, and corresponding software systems. In this way, teachers and students are located in two separate places, but can achieve the same classroom effect. This paper establishes an interactive teaching system that collects videos of students' training, analyzes their posture and movements during training, and enables students to understand their shortcomings during training. The test results are shown in Fig. 6.

It can be seen that the constructed system can extract the action nodes and contours of students. Teachers and students can analyze the actions through nodes and contours, and then conduct targeted training to improve teaching effectiveness.

3.2. Teaching effectiveness

A total of 10 participants (7 males and 3 females) were selected for the experiment. Before the experiment begins, experiment purpose and testing process were informed to testers, and information was collected from the testers. The testers' form based on their understanding of the 400 m running was determined. Then system testing was conducted, including browsing and interactive learning experiences, and a questionnaire survey was completed. The scores of 10 students before and after teaching were statistically analyzed, and the results are shown in figure [7(a, b)].

From Fig. 7, it can be found that before teaching, the students' test scores were basically between 62 and 65 s, but after action correcting through the system's teaching, the students' test scores showed a significant improvement, ranging from 56 to 57 s, with an increase of 6–7 s. This is because the selected students did not receive professional training before, resulting in a significant improvement. If the testers were professional athletes, the increase could be between 1 and 2 s. After receiving systematic training, the evaluation scores of the students in the 400 m race have significantly improved compared to those who did not receive training. The score has improved by 6–7 s, with a noticeable change. This indicates that the use of interactive AI systems has played a positive role in the physical education teaching of students.

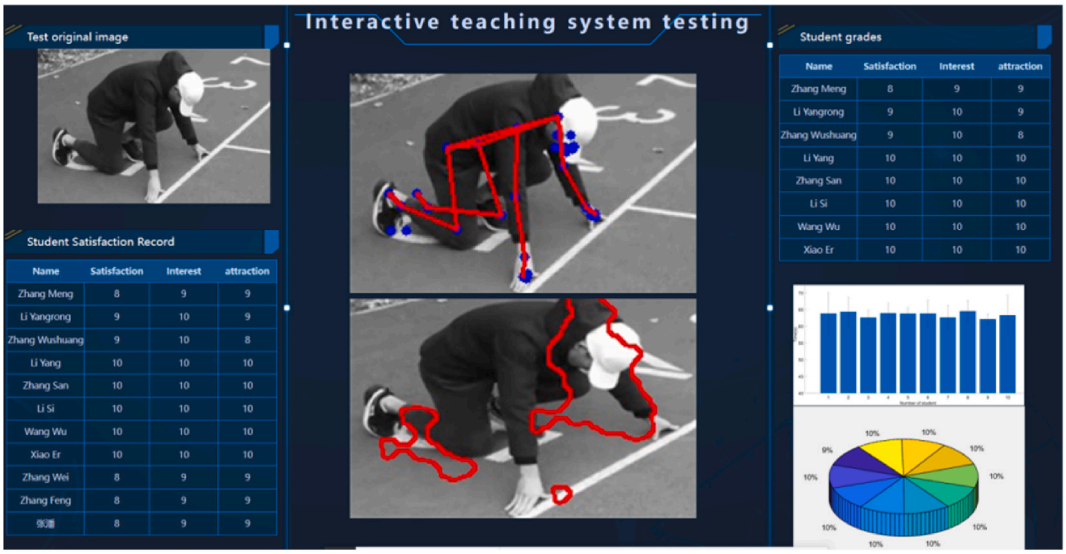

Fig. 6. Effect of student testing.

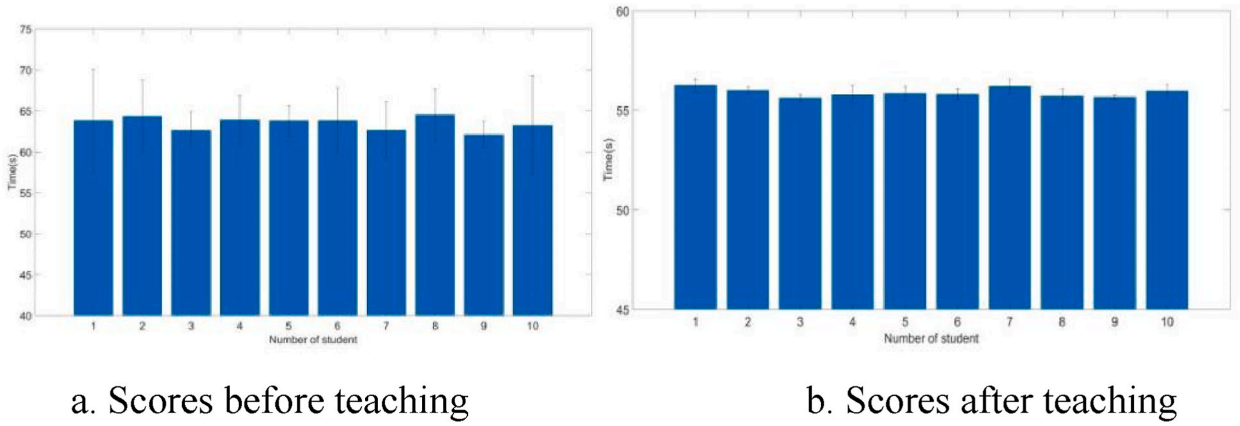

Fig. 7. Comparison of scores before and after teaching.

3.3. Questionnaire results

A questionnaire survey was conducted among the participants in the test. Firstly, the users' feelings towards the interactive system were studied, and a questionnaire survey was conducted on the users' feelings after the experience ended, including modules of interest: introduction of action information, action model, interactive experience of action learning, and interface design. The results are shown in Table 1.

The testers provided feedback on the experience of the interactive teaching system. The results showed that the favorite module for testers was the interactive experience of action learning module, followed by the action model animation, and users were more inclined to obtain an intuitive experience. Most of the participants were satisfied with the interaction between the various modules of the system. Compared with other teaching methods, participants found interactive teaching systems to be more interesting, interactive, and charming.

The satisfaction survey for testers was divided into 10 levels, ranging from 1 to 10 points. The higher the score, the higher the satisfaction. The satisfaction survey included user satisfaction with the interactive teaching system experience, the fun of the interactive teaching system, the attractiveness of the interactive teaching system, and the learning promotion function of the interactive teaching system. The system satisfaction survey is shown in Table 2.

The results showed that the subjects had the highest interest in the interactive experience module of motor learning, followed by motion mode animation, and users tended to experience directly. The vast majority of the participants were satisfied with the interactive effects of the various modules of system. 70 % of people believed that they could have a better understanding of physical education teaching after passing through the interactive teaching department. Compared to other teaching methods, testers believed that interactive teaching systems were more interesting, interactive, and attractive.

4. Conclusions

With the rapid development of computer technology, people have more choices for physical education teaching. Traditional physical education teaching methods have become increasingly difficult to meet their teaching needs. Therefore, building interactive artificial intelligence physical education teaching has become an inevitable trend of development. The interactive AI teaching system constructed in this article can effectively analyze students' shortcomings by extracting their action contours and action nodes, laying the foundation for targeted teaching in the future. This article provided a specific example to illustrate how to apply somatosensory technology to the classroom, and provided a detailed analysis and discussion on the design, implementation effectiveness, and

Table 1
Survey results of interactive systems.

	Introduction of action information	Action model	Interactive experience of action learning	Interface design
1	Very satisfied	Satisfied	Very satisfied	Very satisfied
2	Satisfied	Satisfied	Very satisfied	Very satisfied
3	Very satisfied	Satisfied	Satisfied	Very satisfied
4	Very satisfied	Satisfied	Satisfied	Very satisfied
5	Very satisfied	Very satisfied	Satisfied	Satisfied
6	Very satisfied	Very satisfied	Very satisfied	Very satisfied
7	Satisfied	Satisfied	Very satisfied	Very satisfied
8	Very satisfied	Satisfied	Satisfied	Very satisfied
9	Very satisfied	Very satisfied	Satisfied	Satisfied
10	Very satisfied	Satisfied	Satisfied	Satisfied

Table 2
Satisfaction survey of the system.

	Interactive teaching system experience	Fun of the interactive teaching system	Attractiveness of the interactive teaching system	Learning promotion function of the interactive teaching system
1	8	9	9	9
2	9	10	10	10
3	9	9	8	9
4	10	10	10	10
5	9	9	9	9
6	9	8	8	9
7	9	10	9	8
8	8	10	9	10
9	10	10	8	9
10	9	9	8	8

problems encountered in user research experiments of the system. Afterwards, a questionnaire is conducted from the perspective of user experience, collecting data on the system's experience, attractiveness and other aspects, and conducting research and analysis for further improvement and promotion. In the design and implementation of the system, there is still room for further improvement in the operation of the database. Meanwhile, with the continuous expansion of the scale of universities, the concurrent processing of the system needs to be further strengthened, so that the interactive teaching information system of universities can be used by more teachers and students.

5. Informed consent statement

The authorization for the use of the images involved in this study was obtained with the informed consent of the subjects.

Ethics statement

The study adheres to relevant ethical guidelines and national laws andregulations. All participants voluntarily took part in this research, and they signed an informed consent form before the commencement of the experiment.This research has been approved by the Institutional Ethics Committee of Yunnan Minzu University，Ethics Committee Approval Number:EC-2023-005.

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7. Methods

we confirm that all methods employed in this study have been conducted in strict accordance with the relevant guidelines and regulations.

Data availability statement

The data that support the research findings are available on request.

CRediT authorship contribution statement

Quantao He: Conceptualization. **Haiping Chen:** Software. **Xiaohe Mo:** Methodology.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:Xiaohe Mo reports article publishing charges was provided by Yunnan Minzu University. Xiaohe Mo reports a relationship with Yunnan Minzu University that includes: employment. Xiaohe Mo has patent issued to Xiaohe Mo. After careful consideration and review, we confirm that there are no financial or personal relationships related to the content of this study that could be perceived by readers as potential conflicts of interest affecting the judgement of the authors. Furthermore, we have not served in an editorial capacity for the journal to which this article has been submitted, nor have we had any involvement in the peer review process. Therefore, we declare that there are no conflicts of interest in the submission and publication of this manuscript. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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