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Application of Multimedia Man-Machine Interaction in College Physical Education Teaching

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ABSTRACT

In the realm of physical education in college, the traditional classroom teaching approach primarily relies on paper textbooks and demonstrations by the teacher. However, in today's physical education classrooms, there is a need to change these traditional teaching methods. Utilizing multimedia technology and interactive interfaces, teachers can demonstrate the essential actions and intricate details through multimedia videos and other formats such as push-pull and shaking. This chapter introduces a multi-segment human body tracking algorithm that focuses on real-time tracking. The human body target is divided into multiple segments, and an online learning method based on Hough Forests is used to learn the overall appearance of the human body and the appearance model of each segment. The research findings indicate that when the merged area exceeds 82.36% of the pre-segmentation area using watershed analysis, smaller areas lead to faster segmentation speed, while larger areas result in slower segmentation speed. Compared to other methods, this approach yields better recognition results.

KEYWORDS

Man-machine interaction, Multi-segment human body tracking algorithm, Physical education, Target segmentation

INTRODUCTION

With the rapid development of information technology and continuous innovation in the field of education, the application of multimedia technology in university physical education has become a research field of great concern. Multimedia technology delivers knowledge to students by presenting images, sound, text, animation, and other forms, making abstract concepts and theories more intuitive, vivid, and easy to understand. This interactive learning environment can improve learning efficiency and stimulate learning interest and active participation.

In university physical education, the application of multimedia technology provides teachers with a wealth of resources and tools to display and demonstrate sports skills, rules, and strategies better and to transform abstract concepts into visual forms, thus helping students to better understand and

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master sports knowledge. For example, with technologies such as video, simulation software, and virtual reality, students can watch and mimic the movements of professional athletes, provide real-time feedback to correct their own movements and improve their skill levels and sports performance (Gong et al., 2018).

In addition to providing high-quality teaching resources, multimedia technologies can enhance interaction and engagement between students and the content. With tools such as interactive software, online discussion platforms, and virtual laboratories, students can actively participate in physical education teaching, interact, and collaborate with teachers and other students in real time, share ideas and experiences, and solve problems together. This interactive learning environment not only helps develop teamwork and communication skills but also stimulates innovative thinking and problem-solving abilities.

In addition, the application of multimedia technology can also be personalized to meet student learning needs and interests. Through the intelligent learning system and personalized learning path design, students can learn according to individual learning styles and rhythms, choose learning resources and activities suitable for themselves, and improve their learning effect and independent learning ability. At the same time, multimedia technology can also provide students with real-time feedback and assessment to help them adjust their learning strategies and improve their learning methods in time.

In summary, the application of multimedia technology in university physical education has great potential. It can not only provide rich teaching resources and tools, enhance the interaction and participation between students and teaching content, but also meet students' individual learning needs and interests. By comprehensively utilizing multimedia technology, we can bring more flexible, rich, and effective teaching methods to university physical education, improve physical education quality, and promote their overall development. Therefore, it is very meaningful to further study and explore the application of multimedia human–computer interaction in university physical education.

This paper presents a segmentation algorithm used to analyze interactive videos and a multi-target real-time tracking algorithm in a multimedia human–computer interaction environment, which integrates vision and hearing and allows teachers to provide students with more personalized guidance and correction. This study brings important implications for university physical education curriculum development and teacher training. The multimedia human–computer interaction technology has improved teachers' understanding of students' motor skills and facilitated the innovation and personalized design of course content, as well as promoted the updating of teacher training courses to enhance teaching quality and efficiency.

RELATED WORK

Chen et al. (2012) discussed the application of multimedia technology in college physical education through techniques including the documentary method, professor interviews, and mathematical statistics. It shows that multimedia technology has a positive influence on college physical education, as it promotes scientific, advanced, and vivid development of college physical education. Zhou (2016) studied smart classrooms and multimedia network teaching platform applications in college physical education teaching. Analysis of multimedia network teaching platform applications based on cloud computing through a questionnaire showed that the use rate of multimedia teaching in physical education was 75.6%.

The application of somatosensory technology in multimedia interactive teaching systems can make the teaching system solve many problems in human–computer interaction. Chen et al. (2019) analyzed its application in the teaching model. Students can experience the new teaching experience of somatosensory technology in multimedia teaching, making the abstract content in teaching more vivid, visual, and concrete.

Computer technology, network technology, and multimedia technology are developing rapidly and being used more and more widely, which brings hope for the modernization of educational technology and provides power for the reform of physical education. By means of teaching experiments, Zeng (2020) analyzed the application effect of multimedia in college sports swimming classes and studied the application value of multimedia in college sports swimming classes, hoping to have a certain positive impact and reference significance on improving the quality of college sports swimming classes.

Currently, there is little research on using multimedia animation technology to assist in teaching and training basketball tactics in college. From the perspective of the development trend of modern education and the benefits of multimedia technology in physical education teaching,Yan (2021) illustrated the necessity of integrating multimedia technology into college basketball instruction and the practicality of introducing multimedia-based physical education programs in higher education institutions. By exploring the multimedia teaching environment and teacher instructional capabilities, Yan analyzed the factors influencing the effectiveness of multimedia-assisted teaching.Combined with the problems of traditional physical education in colleges and universities, the application of multimedia network teaching platforms in physical education, Huang and colleagues (2021) discovered that utilizing multimedia network teaching platforms in college physical education can enhance the flexibility of physical education programs and standardize physical education assessments at the college level.

Computer networking is considered one of the prominent aspects of the information society (Da-Wei et al., 2018). The advancement in information technology education has led to reforms in curricula in different countries (Gómez et al., 2021). Liu and Ning (2021) explored multimedia courseware to enhance the understanding of movement techniques and create clear and coherent visualizations for students. Qi et al. (2021) introduced multimedia technology in the classroom, specifically in physical education, which has positively influenced teachers and students by creating an engaging learning environment and stimulating students' interest in the subject. Li et al. (2021) examined the significance of multimedia technology in physical education in human–computer interaction and identified factors that may limit its effectiveness. Shi et al. (2021) emphasized the importance of considering multimedia characteristics and teaching practices when designing courseware, aiming to balance science, standardization, conciseness, and artistic appeal.

METHODS AND MATERIALS

Feasibility Analysis of Multimedia Interactive Platform Application

Traditional physical education classroom teaching in colleges and universities relies mainly on paper textbooks and teacher demonstrations. However, the incoherence of teaching demonstrations can lead to student misunderstandings and reduced learning interest (Ding et al., 2020). The application of multimedia technology effectively makes up for this deficiency. Students can use multimedia technology to record sports videos and submit them to teachers, who can view them online and provide more personalized instructions and corrections. Encouraged by the current advanced educational concepts, theoretical knowledge, and practical training can be seamlessly combined through the scientific use of multimedia technology (Liang, 2019).

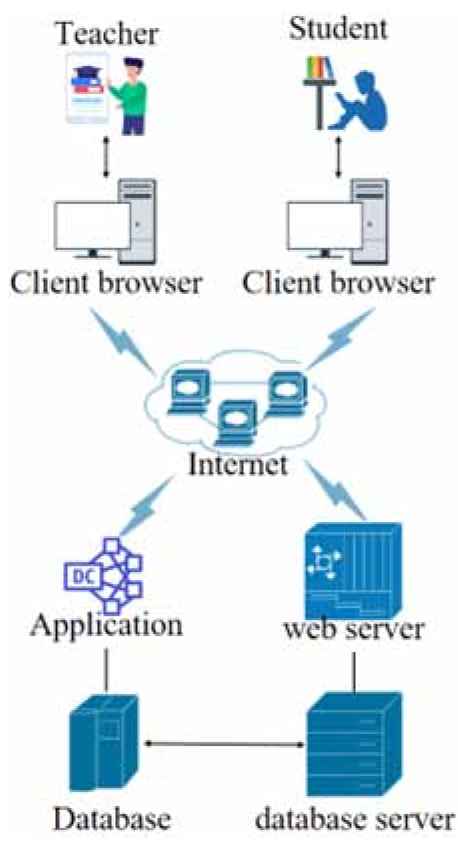
This not only improves the development speed of physical education teaching in colleges and universities but also ensures the improvement of the quality of physical education classroom teaching. Teachers can enhance the intuition of teaching content through multimedia, making it easier for students to understand. The concept of human–computer interaction in multimedia follows a similar idea. To effectively educate students, teachers must combine their teaching input, students' learning ideas, and the transmission of teaching materials and adjust their teaching methods accordingly. Unfortunately, many teachers spend more time focusing on the distinctive features of multimedia courses when integrating multimedia into physical education classroom teaching, thus neglecting the actual needs of students and not giving full play to the role of multimedia.

In the case of multimedia human–computer interaction, teachers utilize tools such as multimedia videos to gradually demonstrate the essentials and details of the movements, thus further ingraining the motor skills in the students' minds and enabling them to become more proficient in each movement (Jiao et al., 2020). Human–computer interaction can effectively integrate sports knowledge with visual and auditory elements in a dynamic form. This highlights the important role of multimedia technology in enhancing the learning of relevant knowledge. In the design of multimedia human–computer interaction, teachers should gradually transition from a teacher-centered teaching approach to a student-centered and student-driven teaching approach.

Multimedia technologies play an important role in supporting teachers and students in their dual roles, but challenges can still arise due to inappropriate use or misunderstanding of their application. The use of online teaching and learning platforms breaks through the constraints of time and space and allows students to continue learning about physical education outside of the classroom. This research topic provides valuable insights into the wider implementation and practical application of multimedia human–computer interaction technologies in physical education. The term *network multimedia man–machine interaction platform* refers to the fact that it was created in network mode, that it can operate on a regular browser, and that both professors and students can communicate and interact using the network multimedia human–computer interaction platform. Figure 1 depicts the multimedia interaction structure.

Students have the opportunity to explore educational literature resources, view instructional images, and watch instructional videos based on their specific needs. Students who struggle with technical movements can correct their errors by comparing their mistakes to the examples provided

Figure 1. Multimedia human–computer interaction structure diagram



in the educational materials. The teaching plan is uploaded to the multimedia system for sequential browsing by students, allowing them to analyze and compare the standardized technical movements of exceptional athletes.

Object Segmentation in Interactive Video

Object segmentation in interactive video is the segmentation of a target in a video that allows the user to interact with the objects in the video. Interactive video segmentation technology has important application value in physical education. This technology can help teachers use multimedia to make boring traditional teaching activities more vivid and interesting and create a relaxed learning atmosphere (Yoon et al., 2018). By presenting the teaching content through audio and video teaching technology, the teaching process can be turned into a passionate emotional cultivation process. In addition, interactive video segmentation technology can also help teachers better guide students and improve the smooth experience of athletes, thus improving sports performance. In sports teaching, accurate and efficient segmentation algorithms are the basis for supporting these application systems, which directly affect the success of the subsequent processing and have a great impact on the difficulty of the subsequent processing of the system. Therefore, combining interactive video segmentation technology in university sports teaching can create a good modern multimedia teaching environment for teachers and students and help realize the teaching goals.

The derivation of a two-dimensional situation is based on the translation transformation between two images. The derivation process can be extended to any linear transformation, such as rotation, scaling, and false cutting. There is such a relationship:

$$g\left(x\right) = f\left(Ax + h\right) \tag{1}$$

where A is the transformation matrix between $f\left(x\right)$, $g\left(x\right)$, and the translation vector is expressed as h.

Whether a time domain position $x = \left(x, y\right)$ belongs to the changed area or the unchanged area is based on the value of the frame difference FD:

$$FD\left(x\right) = S_k\left(x\right) - S_{k-1}\left(x\right) \tag{2}$$

where the foreground label is 1 and the background label is 0 (Li et al., 2020). FD is usually applied to a measurement window instead of a single pixel. When the image segmentation is l, the energy function $E\left(L\right)$ can be defined as:

$$E\left(L\right) = \sum_{p \in P} D_p\left(l_p\right) + \lambda \cdot \sum_{\left(p,q\right) \in N} V_{p,q}\left(l_p, l_q\right) \tag{3}$$

where D_p is a data item, which is used to calculate the probability that the node p belongs to the label l_q. The term $V_{p,q}\left(l_p, l_q\right)$ is a smoothing term used to calculate the cost between adjacent nodes p, q; λ is the weight factor between them, which determines the degree of their influence on energy.

Video object segmentation can be regarded as clustering image pixels or blocks in time and space (Delande et al., 2019). The practice has proved that the graph model is useful for image and video object segmentation. This method can obtain the relationship between the local and middle distance of the image, and it is a linear relationship complexity (Emambakhsh et al., 2019). The calculation of the super edge is equivalent to the generation process of some attributes of the image block of the picture. According to different standards, we regard the task of attribute assignment as a binary classification problem. After the vertices and edges are obtained, the hypergraph is established. The image can be divided into different targets by hypergraph cutting. The algorithm flow chart is shown in Figure 2.

This over-segmentation operation provides good preparation for the next advanced reasoning of the temporal-spatial relationship between small patches (Jondhale & Deshpande, 2019). Finally, some representative two-way segmentation results will be selected to represent the attributes of these image blocks.

After using the multi-scale graph decomposition algorithm to get the image blocks that are over-segmented in the time and space domains, these image blocks are described by the optical flow and appearance based on the motion contour, which is denoted as $f^{\circ} = \left(u, d\right)$.

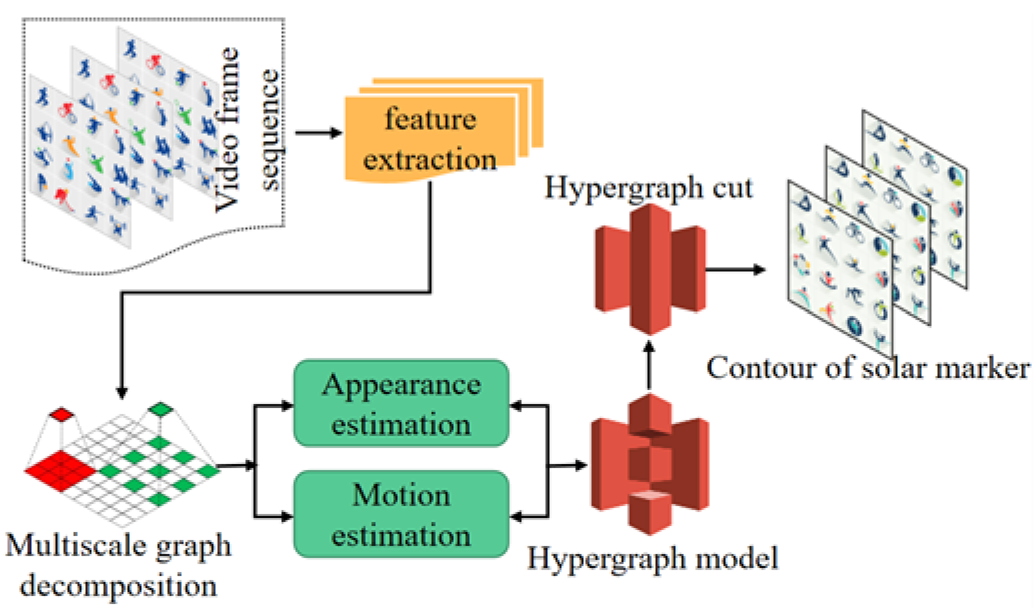
$$u = \frac{1}{N}\sum_{i} w_i z_i, d = \frac{1}{N}\sum_{i} w_i o_i \tag{4}$$

where N is the number of pixels in the image block, and w_i is the weight generated by the low-pass 2D Gaussian distribution centered on the image block. The term u, d represents the motion intensity and motion angle of the image block, respectively (Ji et al., 2019).

Then, the m-value color kernel histogram of the target model can be expressed as:

$$\hat{q}_u = C\sum_{i=1}^{n} k\left(\left\|\frac{x_i - x_0}{h}\right\|^2\right)\delta\left(b\left(x_i\right) - u\right)u = 1, 2, \cdots, m \tag{5}$$

Figure 2. Flow chart of video object segmentation algorithm based on hypergraph cutting



where $k\left(\|\cdot\|^2\right)$ is the contour function of the kernel function, and h is the bandwidth of the kernel function, which determines the search range of the mean shift algorithm.

The smoothing term $V\left(l_{v_i}, l_{v_j}\right)$ calculates the cost when the adjacent grid cells v_i, v_j are assigned different labels, which takes the form of the standard Potts model:

$$V\left(l_{v_i}, l_{v_j}\right) = \begin{cases} 0, & l_{v_i}, l_{v_j} \\ \left|v_i\right| \cdot \left|v_j\right| \cdot \exp\left(-\beta \cdot d\left(f_i, f_j\right)\right), & l_{v_i} \neq l_{v_j} \end{cases} \tag{6}$$

where $\left|v_i\right| \cdot \left|v_j\right|$ is the number of pixel points of grid unit v_i, v_j, respectively. The term FD is the visual characteristic distance between adjacent grid cells FD, which is used to calculate the color difference between them.

Considering that the algorithm ultimately needs a high-precision matching set, the algorithm selects the re-projection error between the accurate feature-matching pixels extracted from the source image window and the target image window as the matching cost (Chen et al., 2021). The formula for matching cost function between two matching windows is as follows:

$$C\left(x, y\right) = \sqrt{\frac{\sum_{i=1}^{N}\left(p_{1i}^T F^T p_{2i}\right)^2}{N}} \tag{7}$$

where x, y is the position of the top left corner of the source image window on the source image, N is the number of feature points in the matching set filtered by the algorithm, p_{1i} is the feature point on the source image window, p_{2i} is the matching feature point on the target image window, and F is the basic matrix between the source image and the target image.

Given the video frame X and the model parameter λ_k, v, μ, we can calculate the real tag layer in the layered conditional random field model:

$$\hat{L} = \arg\max_L P\left(L \middle| X; \lambda_k, v, \mu\right) \tag{8}$$

The copy function $\Gamma\left(\cdot\right)$ is used to label video frame X. It is used to map the random variables of the real label layer and pixels of a video frame X in a layered conditional random field model.

Multi-Target Real-Time Tracking Algorithm

Multi-target real-time tracking algorithms refer to a class of algorithms that are capable of tracking multiple targets at the same time and can operate under real-time requirements. Such algorithms require efficient target detection and tracking capabilities, as well as the ability to handle complex scenes and occlusion situations, so that they can accurately recognize and track the motion trajectories of multiple targets.

Physical education, like other subjects, is purposeful, cultivating moral character and forming personality. However, it has its own particularity, and it is one of the ways to achieve school physical education goals. The main goal of physical education is to selectively impart physical knowledge, technology, and skills, cultivate student interest and ability in self-exercise, and promote physical development and keep fit. Under the background of the new era, as an important guarantee for the sustainable development of educational informatization and the main force to promote the combination of multimedia technology and teaching, it is not ideal for teachers to improve their multimedia skills through self-study.

Through training and self-study, the ability to operate multimedia equipment and software of physical education teachers in colleges and universities can be improved, making physical education teachers' relevant skills handy, to develop distinctive multimedia teaching. Keep learning according to the teaching tasks and the requirements of modern teaching. Only when physical education teachers have their own excellent qualities can multimedia teaching have rich content support and rich knowledge connotation, and the real value of multimedia physical education teaching can be fully realized.

From an image processing perspective, target tracking involves continuously detecting and tracking a specific object in a sequence of images to determine its motion trajectory (Wang et al., 2022). This process requires estimating the object's state, which is uncertain due to noise in the observations. Therefore, tracking can be mathematically formulated as a state estimation process in a random system. When designing multimedia courseware for teachers, it is important to consider several requirements. The content and subject matter should be logical and reasonable. Quotations, production, and revision should be properly integrated. The interface design should be well thought out. The courseware content should be appropriate for the intended audience. Various tools should work together to enhance the learning experience.

To continually improve the skills of creating courseware, it is essential to seek advice from experienced teachers in different disciplines. By doing so, we can ensure that the courseware meets the standards of the current times and enhances the quality of education. It is also crucial to improve the efficiency of courseware creation without compromising its quality. It is important to align the capacity of the courseware with the actual teaching requirements to avoid excessive materials and data. Additionally, the selection of data should consider student interests and engagement.

A binary classifier decision-making process can be regarded as a Bernoulli stochastic process with a success rate of P. Assuming that the HF (Hough forests) classifier is composed of T trees, the number of training samples reaching each leaf node of each tree is R. According to Bernoulli's stochastic process theory, the probability of correct classification by HF classifier is:

$$S = \sum_{i=\left|\frac{n}{2}\right|+1}^{n} \binom{n}{i} p^{i} \left(1-p\right)^{n-i} \tag{9}$$

where n is the number of Bernoulli process tests, that is, $n = R * T$.

The affine transformation is a common geometric transformation of images (Ramsey et al., 1999). Let $\left(x_i, y_i\right)$ be the coordinate of a pixel in the image, and the coordinate after affine transformation is:

$$\begin{pmatrix} x_2 \\ y_2 \end{pmatrix} = \begin{pmatrix} t_x \\ t_y \end{pmatrix} + s * \begin{pmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{pmatrix} \begin{pmatrix} x_1 \\ y_1 \end{pmatrix} \tag{10}$$

where t_x, t_y is the translation in the x, y direction, θ is the rotation angle, and s is the scale factor. An affine transformation is determined by solving these four parameters.

As an important preprocessing step in image processing, a color model is widely used in image and video analysis systems. For example, skin color detection based on statistical color models is important in many applications. Gaussian mixture model is represented as follows:

$$P(R,G,B)=\sum_{i=1}^{N}\pi_i N(\mu_i,\Sigma_i),\sum_{i=1}^{N}\pi_i=1 \tag{11}$$

where R,G,B represents a vector in the color gamut space, the weight of the i th mixed component of Gaussian mixture model is π_i, the mean value is μ_i, and the covariance matrix is $\sum_1$.

Let the disparity of pixel (x,y) in the disparity map of the current frame image be $f_l(x,y)$, and the disparity of pixel (x,y) in the background disparity map obtained by background modeling be $C_l(x,y)$, and perform a differential operation on the disparity map of the current frame image and the background estimated image as illustrations to detect the foreground. The detection formula is as follows:

$$D(x,y)=\begin{cases}1, & \left|f_l(x,y)-C_l(x,y)\right|>k\delta_t\\ 0, & otherwise\end{cases} \tag{12}$$

where k is a constant, usually taking the value of 3, then the binary image $D(x,y)$ is denoised by morphological operation.

The human body target is divided into multiple segments, and the online learning method is based on HF to learn the overall appearance of the human body and the target model of the appearance of each segment. Correcting the previous tracking results at any time also improves the accuracy of target tracking in the current robot. The overall framework of this algorithm is shown in Figure 3.

During the online tracking stage, the video sequence is input to obtain the optimal solution for each target trajectory within the current time window, which is then output as the final tracking result. The CRF (conditional random field) is utilized as an undirected graph model. $G=(N,E)$, was first used to model the segmentation and label calibration of serial data sets. The potential function can be expressed as a weighted sum of a series of characteristic functions:

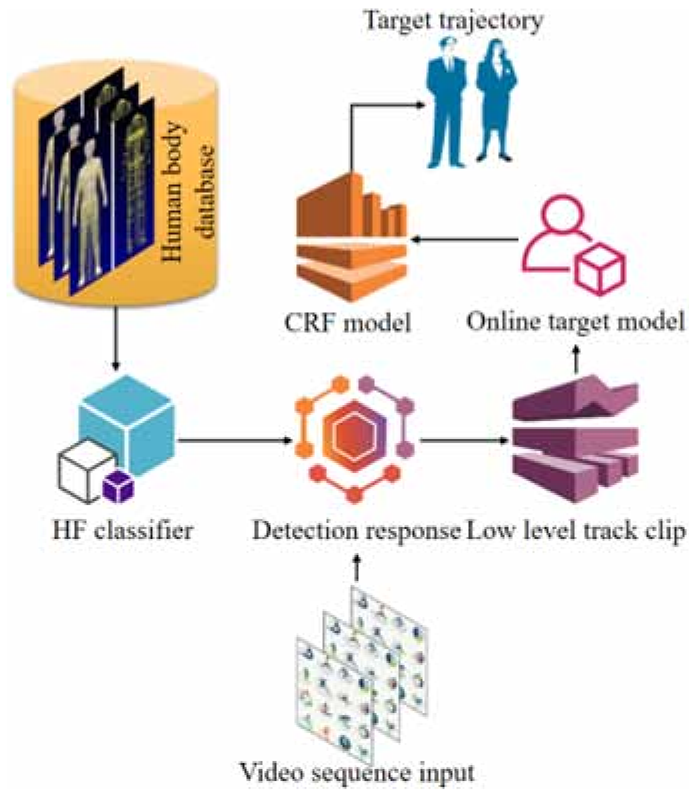
$$\phi_s(y_j,X)=\sum_k \lambda_k f_k(y_j,X) \tag{13}$$

$$\phi_r(y_j,y_i|X)=\sum_k \gamma_h f_h(y_j,y_i,X) \tag{14}$$

where λ_k,γ_k represents the parameter and $f_k(\cdot),f_h(\cdot)$ represents the characteristic function.

The order of its corresponding feature vectors is also adjusted accordingly, and then some of them are selected to construct feature subspace (Luo et al., 2020). The principle of selection is to take the eigenvectors corresponding to the top p largest non-zero eigenvalues; the value of p needs to satisfy the formula:

Figure 3. Overall framework of algorithm



$$e_p = \frac{\sum_{i=1}^{p} \lambda_i}{\sum_{j=1}^{k} \lambda_j}, p \leq k \tag{15}$$

Generally speaking, taking the value of p at $e_p = 0.9$ means that the selected features retain at least 90% of the original energy.

At time t, the gesture observation image is $i(t)$, the projection of the three-dimensional gesture model $M(t)$ on $I(t)$ is $P(t)$, and the Hausdorff distance between $I(t)$ and $P(t)$ is recorded as:

$$h^k(i, j) = Hausdorff(I(t), P(t)) \tag{16}$$

where $i \in I(t)$ is the observed characteristic value of the gesture image and $j \in P(t)$ is the projection characteristic value of the model on the image plane. Specifically, $h^k(i, j) < \delta$ indicates that the model reaches the specified threshold, the initialization is successful, and the initialized model is saved and output.

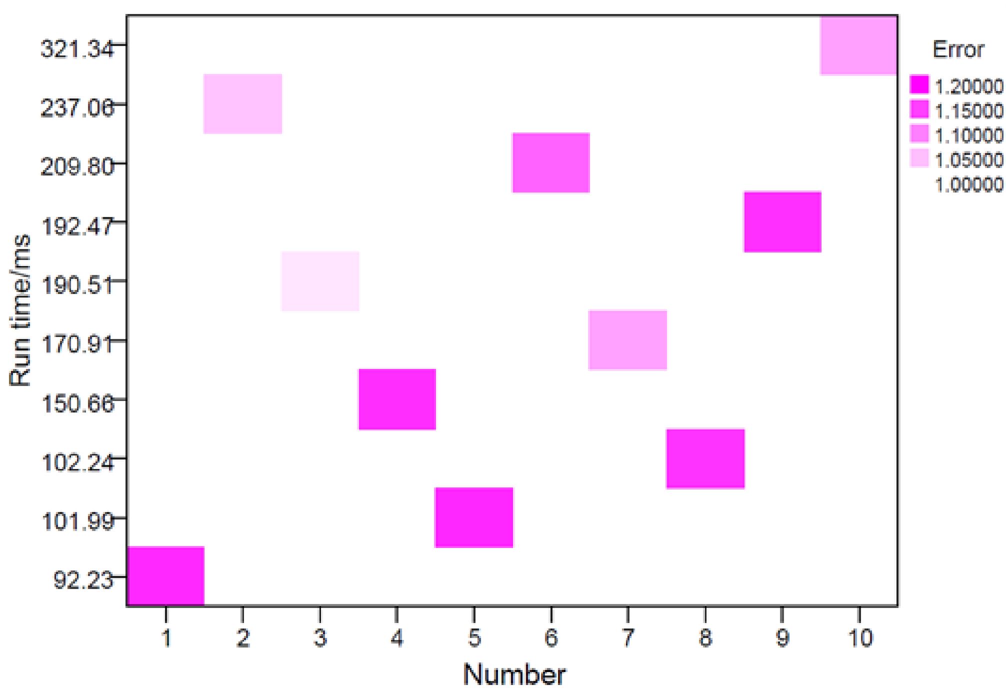
RESULT ANALYSIS

Ten college students were selected, and ten videos, each containing 1500 sample points, were chosen for analysis. In order to prove that the improved algorithm does have advantages in filtering effect and running time. Considering that the sample points of the traditional algorithm are randomly selected, the final experimental result of each group is the average of ten running results. Table 1 records the filtering effects of the two algorithms. Figure 4 shows the filtering effect of the improved algorithm.

Table 1. Comparison of filtering effects

Experimental image number	Traditional method		Improve one's method	
	Error	Running time (ms)	Error	Running time (ms)
1	1.50076	339.47	1.16854	92.23
2	1.62729	167.48	1.04713	237.06
3	1.42772	243.36	1.02061	190.51
4	1.45528	352.92	1.1642	150.66
5	1.4769	218.45	1.16915	101.99
6	1.72517	192.84	1.123	209.8
7	1.59447	298.45	1.07319	170.91
8	1.61106	243.4	1.15975	102.24
9	1.33898	371.84	1.16198	192.47
10	1.51654	296.46	1.0744	321.34

Figure 4. The filtering effect diagram of the improved algorithm



The improved algorithm not only improves the running efficiency of the method but also reduces the false matching rate in the filtered matching result set (Lee et al., 2016). The experimental results show that the matching point set with higher accuracy after coarse filtering can effectively speed up the calculation speed of the traditional algorithm, and the number of excellent matching point sets obtained on this basis is much more than that without coarse filtering. There are not too many pairs of matching points filtered out.

Based on the belief appearance model and the introduction of the high-order uniform energy term, this method can not only accurately estimate the possibility that each grid cell node belongs to the foreground and background in complex scenes but also enhance the label consistency of similar nodes in a long distance, thus achieving high-quality image segmentation results with a small amount of user interaction (Newcomb et al., 2015). Therefore, the details are richer, and the colors are more complicated. In this paper, the confidence appearance model and high-order uniform energy term are combined to further reduce user interaction, thus realizing fast and high-precision segmentation of high-resolution images. To compare the accuracy of image segmentation numerically, as shown in Figures 5 and 6.

In the statistical results of the intersection ratio and *F*-value, the image segmentation result obtained by this method is the best. This method not only constructs the orange appearance model but also combines the high-order uniform energy term to enhance the connectivity of long-distance nodes with similar features, so that the ideal image segmentation results can be obtained with minimal user interaction (Levinson, 2020).

In this paper, the high-order uniform energy term clusters long-distance nodes with similar characteristics, which can not only obtain high-quality segmentation results but also further reduce the amount of user interaction input for images with high resolution (Chen et al., 2022). This method can realize fast and high-precision segmentation of target objects in complex scenes with a small amount of user interaction. In this paper, the fewer regions, the faster the maximum flow algorithm converges, but the region merging algorithm is time-consuming. Therefore, after experimental analysis, as shown in Table 2.

Figure 5. Cross-Parallel ratio of different interactive image segmentation methods

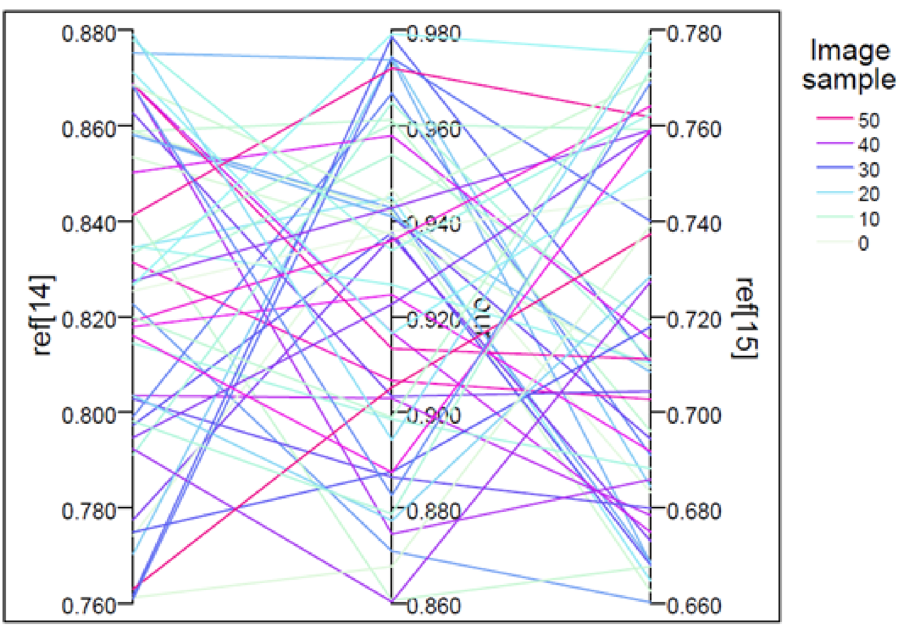


Figure 6. F-Values of different interactive image segmentation methods

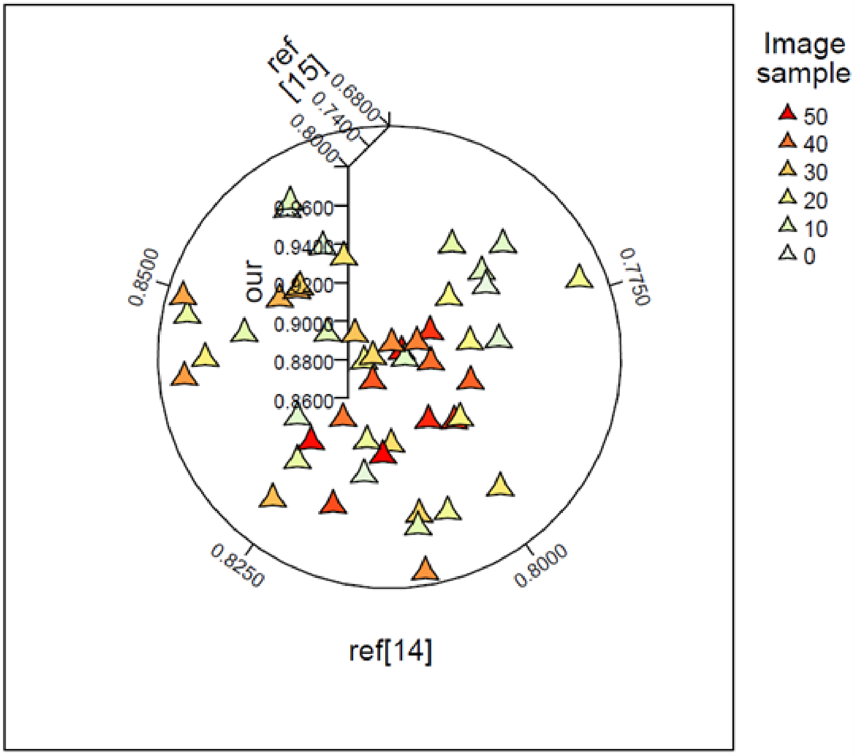


Table 2. Efficiency comparison under different number of regions and different segmentation ranges

Area number	Total graph	Valid split range of the included target
1000	1468.9966	1273.863
1500	1259.5982	1177.1133
2000	1448.1992	1123.5375
2500	1453.7216	1266.2834
3000	1204.7316	1221.2912
3500	1342.7078	1257.1526

In this paper, reducing the complexity of the streaming network by calculating the effective segmentation range containing the extracted daily target will not increase the additional system overhead. Still, it can speed up the segmentation speed. As seen in Table 2, when the merged area is more than 82.36% of the watershed pre-segmentation area, the smaller the area, the faster the segmentation speed.

In order to estimate the error rate of each algorithm, we manually segment each frame of the video sequence to obtain the benchmark segmented image. The error rate of each algorithm is calculated by comparing their segmentation results with the benchmark segmentation image. In the comparison process, all segmentation results are after shadow elimination. The two-layer pyramid structure is adopted, and the bottom template size is 44 (see Table 3).

Table 3. Efficiency comparison in different situations

Experiment	Proposed method (ms)	Traditional method (ms)
Translation	38.065	64.3388
Zoom	37.172	72.2289
Rotate	35.0921	67.6656

Traditional matching algorithms usually have a very large amount of computation (Ren et al., 2021). They can be used to calculate the matching position to obtain high positioning accuracy and provide more accurate parameters for image fusion. In this paper, 30 common gestures are selected for feature point detection experiments; each gesture was detected 10 times, and the experimental picture size was 400 × 300. The experimental results obtained by our feature point detection method are shown in Figure 7.

The average experiment time is 17 milliseconds, the average detection rate is 96.3%, the average misjudgment rate is 3.5%, and there are almost no redundant feature points. Good results can also be obtained for detecting the distance transformation of the hand shape and the gradual change of the hand shape. The algorithm in this paper is compared with the traditional particle filter algorithm, ref[18] and ref[19] 50 times, and its average tracking accuracy is shown in Figure 8.

Figure 7. Experimental results of different gestures

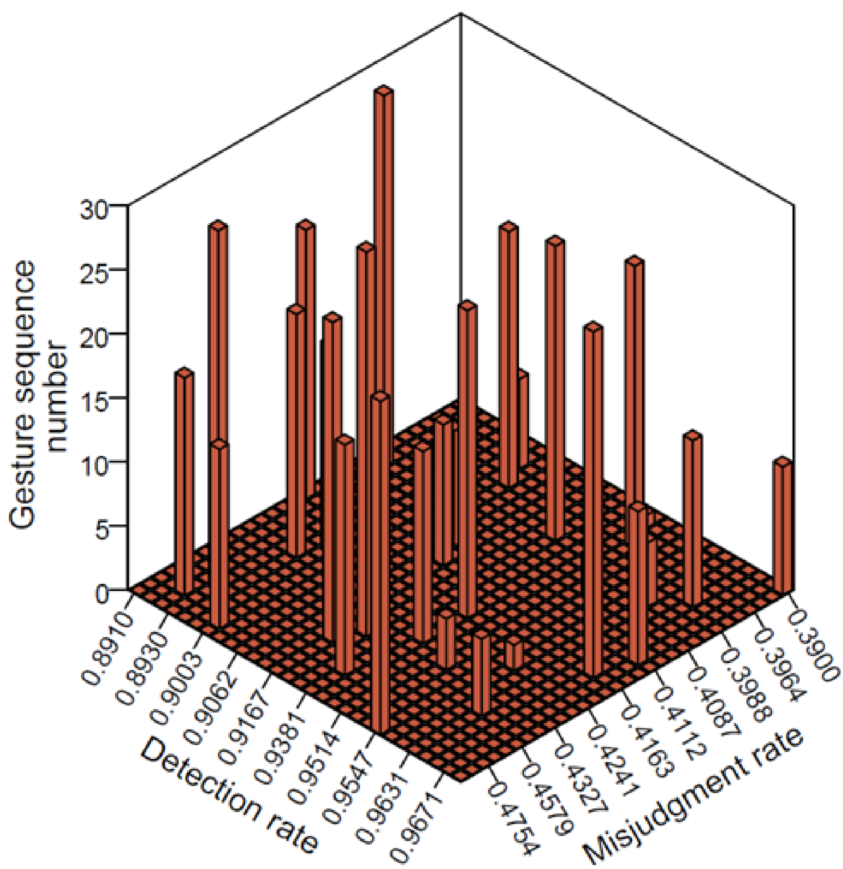
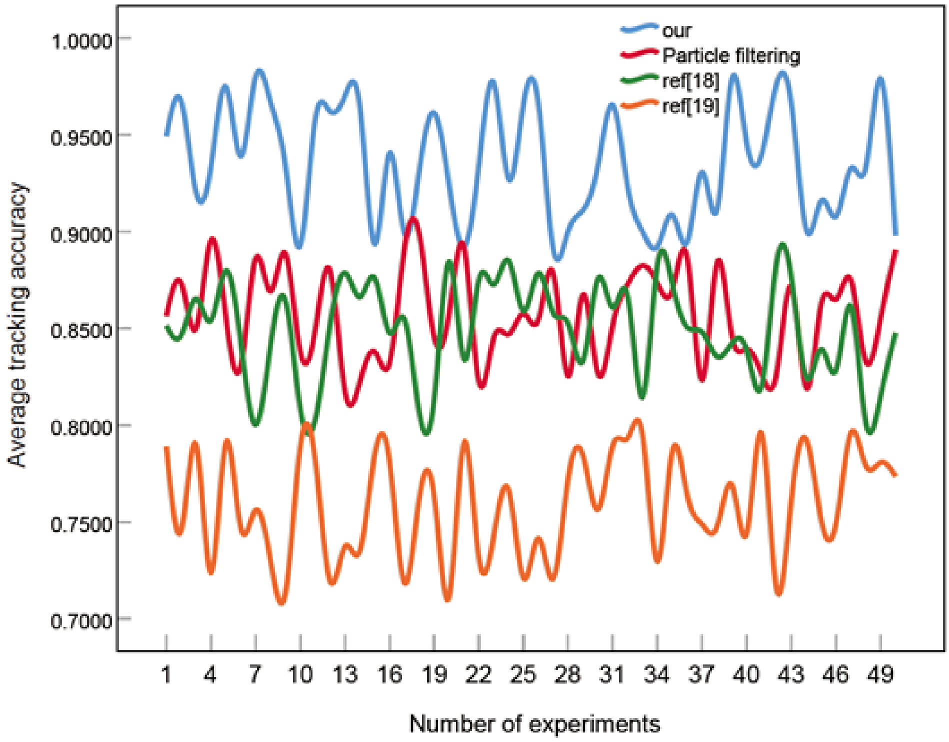


Figure 8. Comparison chart of average tracking accuracy



The single ref[19] algorithm reduces the effect of real-time hand parameters because it relies too much on the model, and its accuracy is relatively low, so it can only be used as a 3D tracking process with low accuracy requirements.

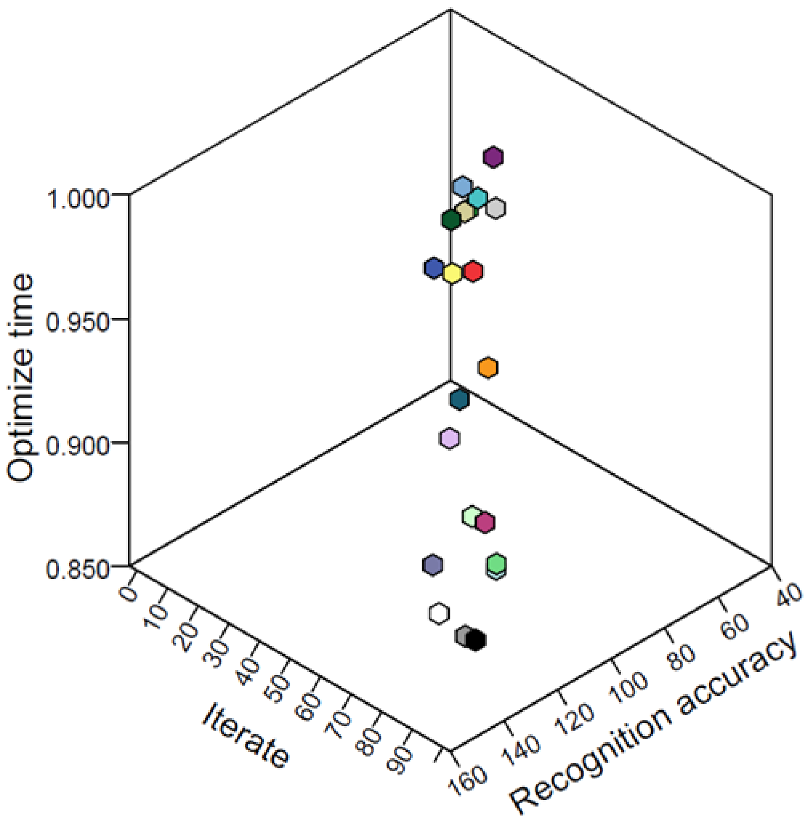
If the number of iterations is too small, the recognition accuracy cannot reach a high level. If the number of iterations is too large and the iteration time is too long, it will affect the recognition efficiency. In the experiment, we constantly modify the iteration times of the algorithm and comprehensively measure and select the best iteration times. Select the integer multiple of 5 each time. The identification result and iteration time are shown in Figure 9.

Before the number of iterations is 30, the recognition accuracy increases with the number of iterations, then shows a downward trend, and a higher recognition rate appears at 70 iterations. However, after 80 times, the time consumption is increasing, even reaching hundreds of seconds, which is unbearable in the recognition system. Considering comprehensively, the number of iteration termination is 30, which is the highest efficiency.

CONCLUSION

Video object segmentation can be regarded as grouping image pixels or blocks in both temporal and spatial dimensions. As a result, the tracking process can be mathematically described as estimating the state in a random process. In this paper, a real-time multi-segment human tracking algorithm is proposed, which aims to divide the human target into multiple segments. The research findings indicate that when the merged area exceeds 82.36% of the pre-segmentation area obtained through watershed segmentation, smaller areas result in faster segmentation speed. Conversely, smaller areas lead to slower segmentation speed when the merged area is smaller. The average duration of the experiments

Figure 9. Influence of iteration times on recognition rate



is 17 milliseconds, with an average detection rate of 96.3% and an average misjudgment rate of 3.5%. Moreover, the algorithm minimizes the number of redundant feature points. The proposed method also achieves satisfactory results in detecting the distance transformation of hand shapes and the gradual changes in hand shapes.

The video object segmentation and real-time multi-segment human body tracking algorithms in this paper provide a new application direction for university sports teaching, which can realize efficient and accurate tracking and data analysis of student movements through multimedia human-computer interaction technology. Teachers can use this technology to understand the level of student motor skills better and provide personalized instruction combined with multimedia content, thus improving teaching efficiency and quality. This method not only helps students improve their movements but also stimulates their interest in learning, promotes overall development, and brings new possibilities for university physical education teaching.

There are limitations to this study. The thesis may be limited to specific regions or types of educational institutions, and its applicability to other regions or types of educational institutions needs to be explored more. Additionally, other factors affecting the effectiveness of teaching and learning, such as the level of teachers, teaching management, and student characteristics, which may have a significant impact on the effectiveness of teaching and learning, have not been explored in depth. Therefore, a comprehensive consideration of these factors is necessary to obtain more comprehensive and accurate conclusions from educational research.

Future research directions of multimedia technology in university physical education teaching include optimizing the application of multimedia technology, exploring the influencing factors of personal motivation and persistence, advancing the advanced application of information technology, developing network teaching platforms, and interdisciplinary cooperation and innovative applications. Through in-depth research and innovation, we can continue to improve the effectiveness of university physical education teaching, stimulate student learning interest and participation, and promote the sustainable development of university physical education.

DATA AVAILABILITY

The figures and tables used to support the findings of this study are included in the article.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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