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CAD Data Mining in Application of Intelligent Sports Training System

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Abstract. Sports identification and intelligent assisted training can effectively improve the effect of physical training. From the current situation, it can be seen that computer-aided training methods are currently used in sports training special operations. However, there is currently no comprehensive training system. In view of this, based on the computer database technology, this study combined the actual movement of athletes and the human body recognition technology to construct a sports training system. Moreover, this paper combined image processing technology to simulate the movement of athletes in motion and verified the model results through experiments. The research indicates that the proposed method has certain practicability and can provide theoretical reference for subsequent related research.

Keywords: database; sports training; system construction; motion system; sports simulation
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1 INTRODUCTION

In the course of the development of sports for many years, sports technology has been continuously developed and progressed, and a large amount of literature has been researched on the basic techniques of sports, and many good basic techniques of teaching and training have emerged. Moreover, there are numerous literatures and monographs that have conducted in-depth research on the practice methods of sports. However, many studies have only studied with one or several basic techniques, and there are few summaries of sports practice methods. Moreover, in many works, only the practice methods of sports are simply stated, but the means of assisting basic technology teaching, and the practice methods are not classified. Through many visits to teachers and coaches, I found that in the past teaching and training process, before each class, teachers or coaches have to spend a lot of time on the choice of practice methods and the preparation of teaching tasks. Moreover, the differences in personal teaching and training levels and insufficient teaching and training experience of young teachers and the lack of practice methods makes teaching and training very boring and makes students feel bored, and over time makes students lose interest in training. In addition, in the preparation of the lesson plan, there are many fixed contents that must be written in the classroom. In the long run, because of repeated content, chaos, and poor organization, the rich experience and practice methods that we have accumulated for a long time cannot be a reference teaching literature.

After the 1990s, with the widespread use of modern science and technology in education and the use of computer network technology as the core of information technology in education and teaching, the way people accept information and knowledge has also changed a lot. A large number of educational practices have proved that educational technology plays an important role in promoting and deepening education reform and cultivating the next generation of innovative talents. Computer-aided education [1] has entered the field of education in the middle of the last century, which has improved the teaching quality of teachers, improved the efficiency of students' learning, expanded the scale of school teaching, and reformed the education and teaching system. Up to now, as the trend and direction of teaching reform in the new era, computer-aided teaching has become a powerful guarantee for the popularization of quality education at all levels of schools. Computer-aided education has also entered the teaching and training of volleyball. Computer Assistant Instruction (CAI) and Computer Management Instruction (CMI) also have a lot of research in volleyball teaching and have been applied in some fields [2]. Different from traditional methods, the advantages of computer-aided education are obvious. Its characteristics are intuitive, interesting, dynamic, analog, conducive to individualized teaching, full human-machine interaction, timely feedback of teaching information, unrestricted collaborative learning, and enhanced teaching management automation. The combination of computer-aided teaching methods and traditional teaching methods makes their respective strengths fully exerted, which can make our teaching level be improved rapidly [3]. Therefore, by using computer-aided teaching to its unique superiority, making full use of information resources, collecting materials, classifying exercise methods according to the basic technical theory of volleyball, and establishing an electronic library of basic volleyball practice methods is a good research entry point.

Bourdon P C et al [4] proposed corresponding countermeasures for the application of CAI in physical education in China according to the status quo, trend, existing deficiencies and history of CAI development in China, to promote the development of CAI in physical education. Gallucci A R [5] believe that the use of CAI modernization teaching methods in physical education can achieve individualized teaching, improve teaching efficiency, and accelerate the reform of physical education, facilitate the teaching of students in accordance with their aptitude, and stimulate students' interest in learning. Weaver A N [6] believes that it is necessary to promote the application of modern educational technology, increase the application of CAI courseware in school teaching, and establish a physical education teaching service system in schools. Manish S [7] expounded the theoretical scheme and production method of CAI design and carried out the experimental design of CAI combination teaching in college sports technical course, and analyzed the test results, and obtained the scientific basis for the application of multimedia combination teaching in physical education. Petek B J [8] studied the development method and teaching mode of CAI courseware in track and field teaching. Li M [9] designed the development method of CAI courseware in physical education based on modern education theory and system theory and produced the courseware of back-style high jump, summed up the advantages of this new auxiliary teaching method. Saponara S [10] expounded the compilation method of CAI courseware and its superiority in teaching by combining its own track and field teaching experience and provided the theoretical basis of CAI courseware assisted teaching. Liu D [11] expounded the principles to be followed in the production of martial arts routines, and used computer programming methods to produce teaching courseware, used CAI courseware to compare and analyze traditional classroom teaching in classroom teaching, and obtained the use effect of courseware, which provided a theoretical basis for using CAI to solve teaching difficulties and exerting students' enthusiasm. Macdonald K [12] courseware for the martial arts routines in the physical education department. He believed that software is an advanced teaching aid, which has great application to martial arts general education, and reduces the workload of teachers and makes up for the shortcomings of traditional teaching. Krivoschekov S G [13] made a comparative study on the learning effects of basketball professional courses and used teaching experiments to find that computer-aided teaching has greater superiority than traditional teaching, and it is very progressive.

2 MOBILE OBJECT DATABASE TECHNOLOGY

With the advancement of technology, wireless communication technology and global positioning systems have gradually become an indispensable part of people's lives. This has also stimulated more demand for mobile trajectory data management, and the concept of moving object trajectories is becoming more and more important. Moreover, relevant research in academia makes it possible to manage dynamic information of moving objects [14].

Moving objects are the subject of mobile object database research, such as vehicles, airplanes, pedestrians, missiles, etc. For traditional database management systems, it is more difficult to process continuously changing locations (generalized location) information. Moreover, frequent updates or insertions in traditional databases can result in poor system performance and inefficient system expansion. Managing the effective management of dynamic location information of mobile objects has become an urgent issue for mobile object database technology. The mobile object database technology has broad application prospects and can be used in common intelligent traffic management systems, military command systems, personnel location tracking systems, and the like. At the same time, mobile object database technology can also be combined with location-related processing techniques to support more complex query types.

Mobile object database technology has emerged in the emerging field in the 1990s, and related research is in its infancy, and many valuable research results have been achieved. However, the emergence of a complete solution for a commercial mobile object database still takes some time [15].

The mobile object database system includes two basic functions: storage of dynamic information of mobile objects and query support of mobile object data. The research goal is to establish a location representation model in the mobile object database and solve key technical problems, such as the data representation and storage under the location label model framework, the storage object index, the location update and prediction strategy, the mobile object query processing, the location-related continuous query, and the environment-aware query processing, etc., and propose practical solutions.

Moving objects can be divided into two categories, moving point objects and moving area objects. The moving point object regards the moving object as a point, and does not need to consider the boundary information of the moving object, such as a mobile terminal such as a moving vehicle, a pedestrian, an airplane, a missile, a mobile phone, or a iPad. However, the moving area object considers its boundary information, and abstracts the shape information of the object that changes with time into a moving area object, such as a migratory animal population, a forest fire, a marine oil spill area, and the like. In addition, the generalized changes can be considered as moving objects, such as temperature changes in a certain area.

On the time axis, the dynamic information of the moving object is monotonically increasing, which makes the historical dynamic information of the moving object incremental. Therefore, there is basically no modification operation on the history information.

Dynamic information management for mobile objects is different from traditional data information management due to its special environmental characteristics. Mobile objects may cause frequent disconnection and low reliability of network connections due to their mobile nature. At the same time, wireless networks are diverse and mostly asymmetric in uplink and downlink bandwidth and low in bandwidth.

The query type of the mobile object is related to the richness of the query semantic support provided by the mobile object database system to the outside world. At the same time, these query semantic requirements are also the inherent requirements of a mobile object information management system. In addition, the query type also determines the index structure used by the underlying storage of mobile object dynamic information and is related to the efficiency of data query and insertion, which is a very important factor to measure system performance.

Update Algorithm 1: When the spatial query window of the query object is in its safe area, it does not have to be processed at this time. However, when the spatial query window of the query object exceeds its security zone, the server needs to report the latest location, and then the server calculates a new security zone and re-executes the query [16].

We assume that the query object is g, which is general. Moreover, we assume that the spatial query window is a rectangle $qo.R$ and the query result set is $qo.result$. $qo.sr1$ is the smallest rectangle that contains the query result set $qo.result$, and $qo.sr2$ is the largest rectangle that contains $qo.sr1$ and does not contain non-query result objects. As shown in Figure 1.

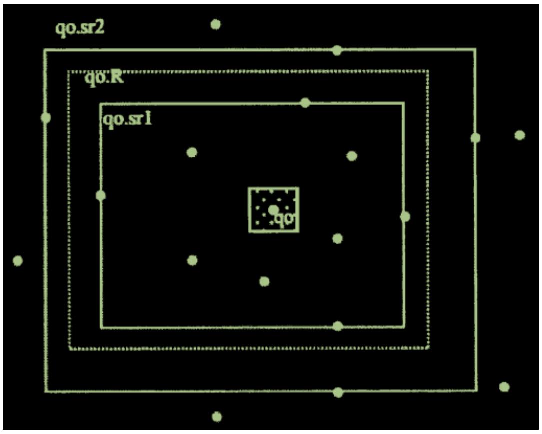

Figure 1: Schematic diagram of the dynamic change of the security area of the query window.

Obviously, $qo.sr1 \subseteq qo.R \subseteq qo.sr2$. The security area of the dynamically changing spatial query window $qo.R$ is the area enclosed by the two rectangular boundaries $qo.sr2$ and $qo.sr1$, denoted as $qo.sr2 - qo.sr1$. The security area does not contain any query targets inside. That is to say, when the query object qo moves, its query window $qo.R$ moves inside $qo.sr2 - qo.sr1$, and the query result set does not change any more. Therefore, at this time, the query target does not need to report its latest location to the server. However, when the spatial query window $qo.R$ of the query object qo moves out of the secure area $qo.sr2 - qo.sr1$, the query object should report its latest location to the server at this time [17].

For a continuous query whose spatial query window is circular, the $qo.sr1$ of the security area of the spatial query window is the smallest circle containing all current result sets and centered on qo. $qo.sr2$ is the largest circle containing $qo.sr1$ that is centered at qo and does not contain any elements in the non-current result set.

Update algorithm 2: In the case where both the query object and the query target position change, the security area of the query object's spatial query window and the security area of the query target change. This situation is more difficult to deal with, and the following is a compromise semi-asynchronous processing method.

For the query target, if it is a specified security zone, the corresponding security query domain also has a corresponding security domain. When the query processing is performed, if it can be directly judged according to the security area, it is directly processed. If it is not directly judged, the corresponding moving object is pushed onto the stack, the location is updated at a fixed synchronization point, and the query is executed.

The above processing method makes the communication cost of the system lower than the synchronous position update algorithm.

The specific implementation process is: For the query object qo, a fixed security area $qo.sr$ is established for it, and a corresponding security area $qo.sr2-qo.sr1$ is established for its spatial query window. The inner side of $qo.sr1$ is the interior of the space query window when the query object moves inside $qo.sr$, and the outer side of $qo.sr2$ is the outside of the space query window when the query object moves inside $qo.sr$. So, $qo.sr2-qo.sr1$ is the safe area of the spatial query window. When qo moves inside $qo.sr$, its spatial query window does not fall outside $qo.sr2-qo.sr1$. As shown in Figure 2, if the security area of the query target O_i is completely inside $qo.sr1$, O_i belongs to the query result set. If the entire region of the query target O_i is completely outside of $qo.sr2$, O_i does not belong to the query result set. In both cases, it is not necessary to update the location of the query target. In these two cases, it is impossible to judge whether it belongs to the result set. It is necessary to query the specific location information of the object, push the query target and the query object onto the stack to update their positions at the synchronization time point, and finally obtain the query result.

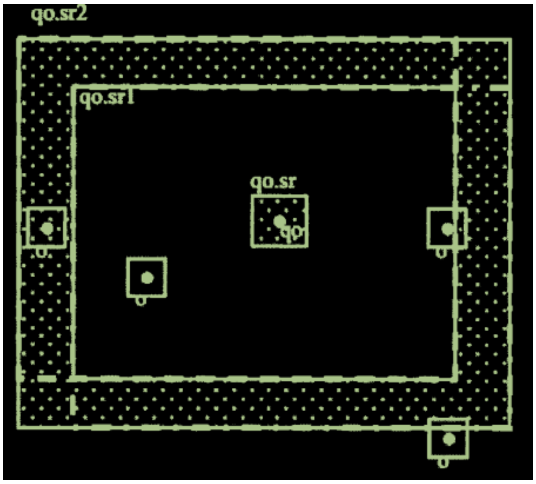

Figure 2: Schematic diagram of the security area of the query object for continuous query.

3 UPDATE STRATEGY OF STSR

The STSR-based update strategy introduced here is a method proposed by Su Chen, Beng Chin Ooi, and Zhenjie Zhangt81 in "An adaptive updating protocol for reducing moving object database workload".

Different from most predicting the future position of the moving object based on the precise position and speed of the last update of the moving object, the S STSR-based update strategy proposes the concept of a spatio-temporal safe region (STSR) to approximate the future position of the mobile object. The STSR provides a larger fault-tolerant area for moving objects as much as possible in the future position and speed of the moving object to reduce the number of location updates.

Location prediction model: We assume that there are n number of moving objects, expressed as $O=\{o_1,o_2,\cdots,o_n\}$. The moving object O_i is represented as a vector $l_i^t=\left(l_i^t.x,l_i^t.y\right)$ at the time t position. At the same time, the corresponding speed is expressed as $v_i^t=\left(v_i^t.x,v_i^t.y\right)$. According to the movement model, we can predict the position pl_i^s of the moving object o_i at time $s(s\geq t)$ according to the position and velocity of O_i at time t.

$$\begin{cases} pl_i^s.x=l_i^t.x+v_i^t.x\cdot(s-t) \\ pl_i^s.y=l_i^t.y+v_i^t.y\cdot(s-t) \end{cases} \tag{1}$$

$$R(O_i)=(LR,VR,t_r,t_e) \tag{2}$$

Among them, LR is the rectangular range of the moving object O_i in the physical space, VR is the rectangle of O_i in the velocity space, t_r is the reference time of the position and speed of the O_i, t_e is the STSR expiration time of O_i and $(t_e>t_r)$. LR can be expressed as:

$$LR=\left[LR.x^L,LR.x^J\right]\times\left[LR.y^L,LR.\mathrm{y}^J\right] \tag{3}$$

VR can be expressed as:

$$VR=\left[VR.x^L,VR.x^J\right]\times\left[VR.y^L,VR.\mathrm{y}^J\right] \tag{4}$$

LR represents the position range of the moving object O_i at the reference time t_r, and the position of O_i is expanded from one point to a rectangular range. VR represents the speed range of the moving object O_i at the reference time t_r, and the speed of O_i is expanded from one point to a rectangular range.

Prediction area: the STSR $R(O_i)=(LR,VR,t_r,t_e)$ of the moving object O_i is given, and the prediction area of O_i at time $t(t_r<t<t_e)$ is

$$p_i^t=\left[p.x^L,p.x^J\right]\times\left[p.y^L,p.\mathrm{y}^J\right] \tag{5}$$

P_i is the extended space rectangle obtained by O_i at time t according to the position rectangle LR and the velocity rectangle VR. Among them,

$$\begin{aligned} p.x^L &= LR.x^L+VR.x^L(t-t_r) \\ p.x^J &= LR.x^J+VR.x^J(t-t_r) \\ p.\mathrm{y}^L &= LR.y^L+VR.y^L(t-t_r) \\ p.y^J &= LR.y^J+VR.y^J(t-t_r) \end{aligned} \tag{6}$$

Of course, the limit of $t_r<t<t_e$ can be relaxed to make $t<t_r$, and the prediction area at this time is

$$\begin{aligned} p.x^L &= LR.x^L + VR.x^J\left(t - t_r\right) \\ p.x^J &= LR.x^J + VR.x^L\left(t - t_r\right) \\ p.y^L &= LR.y^L + VR.y^J\left(t - t_r\right) \\ p.y^J &= LR.y^J + VR.y^L\left(t - t_r\right) \end{aligned} \tag{7}$$

Consistency Verification: When $R(O_i)$ can include all predicted positions of moving objects between time t and t_e, the $R(O_i)$ of the STSR is considered valid at time t. In particular, $R(O_i)$ is consistent at time f and satisfies the following two conditions: (1) The actual position l_i^t of O_i is in p_i^t derived from $R(O_i)$.(2) At time $s\left(t < s < t_e\right)$, its predicted position pl_i^s is still in the prediction region pl_i^s. It is important to note that consistency verification relies only on location and has no constraint on speed.

In general, the location update of the STSR-based update policy consists of two parts: active update and passive update.

Active update: When the STSR-based location update policy is used, there is always one associated STSR $R(O_i)$ for each mobile object O_i, and $R(O_i)$ is stored at both the server and the client. When the position of the moving object changes (or a fixed small-time interval), the mobile object client checks whether the position and speed at this time are consistent with the $R(O_i)$ at the time of the last position update. When they are consistent, no new location update occurs, otherwise the location update is performed, and the server and client calculate a new STSR.

4 SPORTS TRAINING SYSTEM SIMULATION

Athletes can also use Compound shapes, which are automatically constructed. Adding a new shape to an object with a non-mixed shape will produce a mixed shape. The blend shape has a 3-corner limit. After the upper limit is exceeded, the added shape will be ignored. The mixed shape shown in Fig. 3 is composed of capsule shapes as various parts of the human body, and such a shape can obtain relatively accurate results in collision detection, but the positional orientation of each sub-shape is adjusted in real time according to the motion of the model.

Figure 3: Humanoid mixed shape composed of capsule shapes.

The shape of the athlete in the system also uses a mixed shape, but this mixed shape consists only of two mutually perpendicular capsule shapes. Since the posture of the athlete is basically consistent with the mixed shape during the entire competition, it is not necessary to make finer adjustments to the sub-shape, and the system requirements can also be met in the accuracy of collision detection. The PhysX physics engine automatically produces AABB, spherical bounding boxes based on the shape of the character and can quickly detect real-time collisions. Figure 4 shows the shape of the athlete and the AABB and spherical bounding boxes are visible. In addition, PhysX can also make these shapes visible or not.

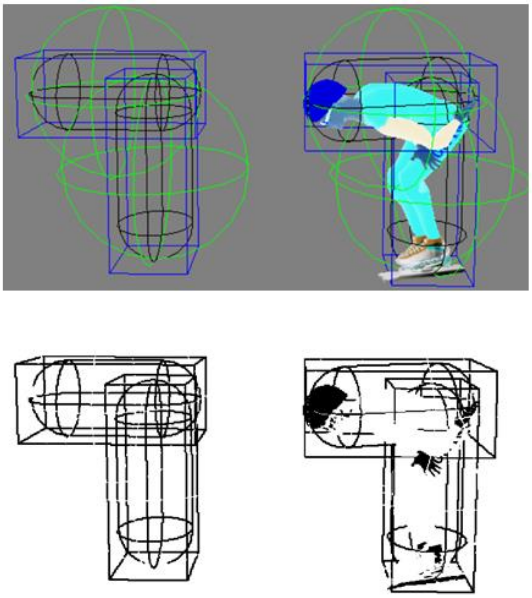

Figure 4: The combined shape of the athlete and its AABB and spherical bounding box.

PhysX performs collision detection based on the shape of the character. If the shape is selected differently, the effect of the collision is different, and the final performance of the program is different. The main activity object in the system is the athletes. Therefore, this paper taken several basic geometric shapes provided by the PhysX physics engine as the shape of the athlete collision detection to carry out the experiment separately and selected the appropriate shape as the geometric shape of the athlete. When the shape of the athlete adopts a spherical shape, the physical shape is not close enough to the athlete's 3D model, and the space occupied is too large, and when the collision is detected, there is a considerable distance between the visual model of the athletes, as shown in Figure 5.

When the athlete adopts the shape of the box, as shown in Figure 6, the physical shape is better for the athlete to be surrounded than the spherical shape, and the space is not very large, which can meet the needs of the system collision detection accuracy. However, due to the angular shape of the box, it will cause difficulties for the control of the athletes. For example, when the athlete slides along the outer wall, there will be inflexibility in the corners.

When evaluating the shape of the athlete's character, the main factors of the evaluation include the accuracy, that is, the accuracy of the collision detection, the simplicity, that is, the creation of the shape and the maintenance of the system operation, etc., and the maneuverability, that is, whether the control of the character is convenient. According to the above experimental results, the evaluations obtained are shown in Table 1.

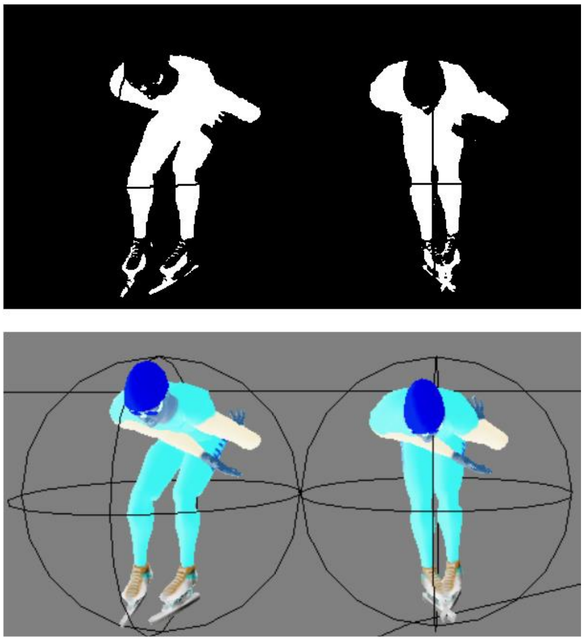

Figure 5: Athletes use a spherical shape.

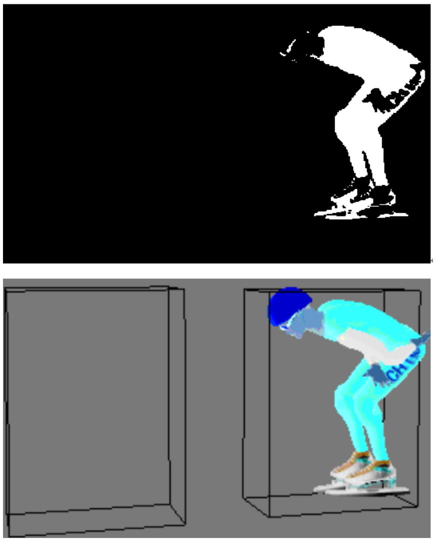

Figure 6: Athletes use a box shape.

Character shape	*Accuracy*	*Simplicity*	*Maneuverability*
Spherical	Bad	Good	Medium
Box shape	Medium	Good	Bad
Capsule shape (full envelop)	Medium	Good	Medium
Capsule shape (partially enclosed)	Bad	Good	Good

Complex shape (main part of the limb)	Good	Bad	Bad
Composite shape (right angle shape)	Good	Medium	Good

Table 1: Evaluation of the character shape of athletes.

As can be seen from the table, it is reasonable for the system to adopt a capsule combination into a right-angle shape as the shape of the athlete. First of all, the accuracy of collision detection meets the requirements of the system, and the accuracy is the highest except for the more complicated shape. Moreover, the control of the athlete is relatively convenient and flexible, and the head of the athlete is located at the position of the hemisphere of the capsule shape and can smoothly slide open when the obstacle is encountered. Moreover, only two capsule shapes in the conforming shape are relatively simple, and it is convenient to adjust even after the 3D character model is changed. Therefore, the system uses this rectangular composite shape as the final shape of the athlete's collision detection.

5 CONCLUSION

Computer-aided teaching software is of great significance for the reform of educational methods, the improvement of teaching methods, and the improvement of teaching quality, and can improve the training effect. Therefore, the development of computer-aided teaching software should be encouraged to improve the application of computer-aided teaching software in sports training. The use of virtual simulation technology in the classroom teaching of physical education courses can stimulate students' academic interest. Moreover, when the virtual simulation technology is applied to the classroom teaching of physical education majors, the combination of in-class teaching, and extra-curricular supervision is adopted to improve students' participation awareness and participation frequency. This method can be used to compare the data obtained in real time, and the students will have a comparison between them, so that students will have a sense of competition, and every practice will go all out. At the same time, this method is more conducive to improving students' performance and improving physical fitness. Compared with the traditional teaching mode, it can improve students' physical fitness more effectively.

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