Improvement of table tennis technology based on data mining in the environment of wireless sensor networks

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Abstract
With the development of Internet of things technology, the combination of Internet of things technology and sports competition parameter collection technology, so as to carry out rapid and accurate retrieval and positioning of technology and tactics, has innovation in the current research field. In the high-level table tennis competition, the use of technology and tactics is closely related to the gain and loss of points. At present, the traditional table tennis video mining algorithm has some problems such as low efficiency and poor performance of optimization classification. Based on this, this article introduces the big data platform of the wireless sensor networks to construct the table tennis match database, realizing the real-time updating of table tennis match parameters and the call of historical data at any time. Then establishing a data mining model to realize the data and dynamic analysis of table tennis matches. Finally, based on this strategic analysis system, the data collected from two table tennis competitions are simulated, and the tactical recommendation of theoretical analysis is obtained, which provides a theoretical basis for the digitization of table tennis sports.

Keywords
Wireless sensor networks, table tennis, sensor, data mining

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networks. F Piccialli et al.\textsuperscript{2} created a price inquiry mobile application based on the wireless sensor networks framework using data mining technology. S Mahbubeh et al.\textsuperscript{3} studied the problem of indoor environment navigation using data mining technology in wireless sensor networks scenarios. The development of the concepts of smart home, smart grid, smart transportation, smart industry, and smart medical treatment is the concepts and technological development route of the combination of wireless sensor networks technology and this field.\textsuperscript{4} Many scholars take the IoT technology as the cutting point, and introduce data mining technology into the field of sports, so as to improve the level of competitive sports. For example, NBA coaches in the United States use Advanced Scout, a data mining tool provided by IBM, to assist in deciding to replace team members on the spot.\textsuperscript{5} RP Bonidia et al.\textsuperscript{6} used data mining technology to study the technical calibration and related parameters in sports, and constructed a sports technology and development system. VS Tseng et al.\textsuperscript{7} established a platform of sports behavior mining and personalized health service based on big data analysis framework for mobile medical technology to provide health protection for users.

Table tennis is a competitive sport of confrontational nature. It requires not only the athletes themselves to have a high level of technical level, but also the use of tactics. In many competitions, the use of tactics will play a decisive role in the victory or defeat of the competition. However, for table tennis players, the traditional training method is relatively single, and targeted is not strong, unable to improve table tennis technology scientifically and efficiently. Therefore, this article studies the improvement of table tennis technology based on data mining in the IoT environment. First, based on the IoT technology, the platform of table tennis game data collection, transmission, and storage is built, and the table tennis game database is constructed. Then, this article proposes a table tennis game analysis system based on data mining technology. Through dynamic reading and analysis of competition data in the database, theoretical analysis and reasonable tactical recommendation are carried out. Finally, based on the tactical analysis system, the data collected from two table tennis matches are selected for simulation. In this study, this article uses data mining technology\textsuperscript{8} and IoT technology in table tennis game analysis, realizes the combination of IoT and table tennis, and quantifies table tennis strategy and tactics based on data mining technology, and realizes the improvement of competition and tactics level.

**The database system of table tennis game in the environment of IoT**

The introduction of wireless sensor networks technology in video processing of table tennis matches promoted the formation of wireless sensor networks video platform based on video analysis. It is different from the conventional video surveillance platform, which greatly improves the usability and monitoring efficiency of the platform. In addition to the conventional functions of traditional video surveillance, it also has intelligent analysis technology. The IoT video platform based on video analysis is an intelligent monitoring platform integrating video image acquisition, data transmission, video data storage, intelligent video analysis, and video browsing. It is mainly composed of front-end equipment and central server. The front-end device is responsible for data collection and transmission, and the central server is responsible for storing and forwarding data of all monitoring sites. It is the data center of the platform.

**Game data collection based on video and wireless sensor networks technology**

Video collection, encoding compression, and transmission are the data foundation of the entire platform, and embedded\textsuperscript{9} video servers and cameras are generally used in hardware. The camera is responsible for video capture, and the video server completes tasks such as encoding and transmission. This article explores techniques such as video capture, compression, and transmission, and presents practical solutions.

**Video capture device.** As the main image sensor, the camera has the advantages of high sensitivity, high precision, and wide spectral response. It has been widely used in military, scientific research, industrial production, and medical imaging. For outdoor complex, large-range, high-density video surveillance, this article uses high-speed dome camera to achieve video signal acquisition.

The cameras are mainly divided into analog cameras, network cameras, and network cameras with built-in video analysis. Analog cameras are classified into three types: gun, hemisphere, and high-speed dome cameras. The output is analog video. Unlike analog cameras, network cameras output digital video signals. The network camera with built-in video analysis also embeds a video analysis module. The gun camera is suitable for areas where there is insufficient light and lighting equipment cannot be installed at night; hemispherical cameras are mainly used in elevators, ceilings, and indoors where light changes are small; high-speed dome cameras have a wide range of applications, both indoors and outdoors.

The high-speed dome camera\textsuperscript{10} integrates cloud platform, communication, and camera. It not only has wide monitoring range, no blind spots, high protection level, but also accurate positioning and can track fast moving...
The video inflow device is a camera, and the program controls the activity of the filter chart through the FGM\textsuperscript{13} (filter graph manager) provided by the Direct Show. The filter converts the data transmitted from the camera, and then outputs the data to the display card through the display. Switch the operator’s perspective to the screen. At the same time, the live video capture can be output to the storage device, and the technical and tactics of the players during the game are collected and output to the database, so that the coach can visually analyze the statistics of the players during the game.\textsuperscript{14} The specific implementation process is as follows:

The process can be described as follows:

- **START;**
- Implement an FGM instance using the API function CoCreatelnstanceOJJ to build the IGraphBuilder interface;
- Use the created FGM instance to call the QueryInteface() function to get the component interfaces of IMediaControl, VideoWindow, IMediaEvent, and so on to realize data flow control, video display, and event information processing for access hardware;
- Find the access video hardware device, if it exists, obtain the ICaptureGraphBuilder interface to realize video preview and acquisition of the access hardware device: (1) If it is a preview of the video, use the Preview pin of the ICaptureGraphBuilder interface. (2) If the video is saved, the capture stitch of the ICaptureGraphBuilder interface is used for video capture, and the game technical and tactical data acquisition is performed at the same time;
- Otherwise, an error message is returned;
- **END**

Collection of video data for table tennis matches. To process the video data of the table tennis game, it is necessary to first save the game video stream to the memory using the video capture device. Since the amount of video data is very large, the storage system is also an aspect that needs to be considered for video data collection. In addition to directly increasing the capacity of the storage system, video compression of data is a very necessary means, and also increases the storage capacity of the system. This resulted in a lot of video compression standards and implemented algorithms and storage formats for video files. This article uses the .AVI format\textsuperscript{11} to process the video.

In order to collect a large amount of technical and tactical data, a script description language is proposed here to solve a key problem. Dynamically bind script description language to video at the same time as video capture. Because the game rhythm is too fast and the script data collected at the game site is not complete, the mechanism for additional acquisition of the simulated scene after the game is provided, and the dynamic binding of the script description language and the video can also be realized.\textsuperscript{12} Figures 1 and 2 show the overall structure of dynamic binding of video and data acquisition, which is a process of principle interpretation. Figure 6 is a table tennis tactical resource management platform, and the above structure diagram is a part of the platform.

### Table 1. Performance parameter table of SCC-C7439P high-speed dome camera.

| Name                      | Parameter                                      |
|---------------------------|------------------------------------------------|
| Effective pixels of the image | 752 (H) × 582 (V) |
| Minimum illumination (multicolor)  | Multicolor: 1.2 Lux |
| Minimum illumination (black and white)  | Black and white: 1.2 Lux |
| Focus                      | Automatic/manual/one-time focus                |
| Digital zoom              | 34× optics, 16× number                         |
| Presetting bit            | 512                                            |
| Monitoring range          | Horizontal 360° continuous rotation, Vertically −6° to 186° |
| Wide dynamic range        | 160×                                           |
| Input voltage             | 24-V AC                                        |
| Power supply              | 16W/47W                                        |
| Operating temperature     | −50 °C to + 50 °C                               |
| Working humidity          | Less than 90% RH                               |
| Level of protection       | IP66                                           |

Targets. Today, it has been widely used in urban surveillance, highways, schools, hotels, hospitals, and other places. This article selects SCC-C7439P high-speed dome camera, and its performance parameters are shown in Table 1.

**Wireless transmission network.** After the data are collected, it is transmitted to the data center by means of transmission. Therefore, data transmission is an important part of the platform, which closely links the front-end equipment to the central server. The video analysis platform based on the wireless sensor networks technology is realized by wireless transmission.\textsuperscript{15,16} The front-end device transmits the video information to the central server through the network through the network, and the central server performs centralized analysis and unified management. Log in to the central server can view the running status of the front-end device in real time, and perform various control on the front-end device by sending control commands. In the case that the network is not blocked, data traffic and network bandwidth determine the real-time nature of
data transmission. The platform mainly involves two data streams of control data and video data, in which the amount of video data is very large, in contrast to the traffic of the control signal can be ignored.

This article adopts the mobile communication technology to realize the transmission of data. The mobile communication technology has evolved from the first generation mobile communication technology (1G) to the fourth generation mobile communication technology (4G). 1G mobile communication technology with analog cellular services has been eliminated. 2G mobile communication technology takes digital voice transmission technology as the core, representing GSM as the global mobile communication system. In the development of mobile communication technology, 2.5G mobile communication technology—GPRS (General Packet Radio Service), CDMA1X, and EDGE communication methods have emerged. However, it can only provide a transmission speed of no more than 150 kbps, less than 300 kbps, which cannot meet the requirements for transmitting CIF video signals. 3G mobile communication technology has a transmission rate of only 153.6 kbps to 2 Mbps. 4G technology network transmission speed can reach dozens of times of 3G network, which can guarantee the speed of data transmission. Therefore, this article uses 4G network to realize the transmission of video data. As shown in Figure 3.
As shown in Figure 3, the structure of wireless sensor network is composed. First of all, high-speed ball cameras are installed in all angles of view at the scene of the game to build a video data collection network. After the start of the game, the high-speed ball camera records the athletes’ technical actions and completes the preliminary data collection. Because video data take up a large amount of memory, the camera is initially compressed and transmitted to the server through 4G network. The server decompresses, classifies, and stores the received data.

Construction of data processing platform based on wireless sensor networks

Basic architecture of wireless sensor networks. The wireless sensor networks (IoT) is the Internet technology connected by things, and it is a new information technology. It mainly contains two meanings: first, the wireless sensor network is an extension and expansion of the basic use of the Internet, it is still the core of the Internet, is developed on the basis of the Internet. Second, it extends and expands to make information accurate between goods and goods, realizes information communication and completes information exchange.

At present, the architecture of wireless sensor networks technology can be divided into three layers: perception layer, network layer, and application layer. The perception layer is the source of collecting data and information. It mainly includes a variety of technologies and hardware with perception functions, such as sensors, bar codes, cameras, and RFID. The network layer is the layer to realize the transmission function in the wireless sensor networks. It mainly transmits the data collected by the perception layer. The network layer includes 4G network, Internet, private line network, and so on. The application layer is between the wireless sensor networks and users, and is the interface for users to use the wireless sensor networks. According to the specific application, the application layer includes intelligent agriculture application, intelligent transportation application, smart home application, and so on. The architecture of wireless sensor networks technology is shown in Figure 4.

The functions of the perception layer include perceiving objects and collecting all kinds of data needed.
Data acquisition in the wireless sensor networks involves sensors, mobile terminals, RFID, multimedia data acquisition, two-dimensional code, and real-time positioning technology. The perception layer is divided into two parts: data acquisition and execution and wireless communication. Data acquisition and execution mainly use intelligent sensor technology, identity recognition, and other data acquisition technology to collect basic data of items, and receive control information from upper network to complete corresponding execution actions. Short-range wireless communication can achieve information centralization and interoperability of multiple items in a small range. For specific perceptual tasks, the perceptual layer usually uses cooperative processing to compute multi-type, multi-angle, and multi-scale information online, and share resources with other units in the network for interaction and information transmission. Its role is equivalent to that of nerve endings such as human eyes, ears, noses, throats, sensory organs, and skin.

The network layer is responsible for transmitting the perceived information and completing a wide range of information transmission. With the help of existing Wi-Fi network, wide area network communication system of 4G mobile network, and wireless Bluetooth technology, the information perceived by the perception layer will be quickly, reliably, and safely transmitted to all corners of the world so that items can communicate over a long distance and over a wide range to achieve global communication. In the early stage of the development of the wireless sensor networks, WAN communication through existing public networks is an inevitable choice for the development of the wireless sensor networks.

The application layer completes the functions of collecting, collaborating, sharing, interworking, analysis, and decision-making of goods and information. It is equivalent to the control layer and decision layer of the wireless sensor networks. It is the interface between the wireless sensor networks and users. It combines with the needs of the industry to realize the intelligent application of the wireless sensor networks, for example, intelligent agriculture applications, intelligent transportation applications, and smart home applications. The essence of the wireless sensor networks is to serve people. The application layer completes the final interaction between objects and people. The perception layer and the network layer collect the information of objects in a wide range and aggregate them in the application layer for unified analysis and utilization.

Construction of wireless sensor networks platform for table tennis technical analysis. Because there is a certain gap time at the end of each round of table tennis match, it is possible for researchers to record the technical and tactical characteristics of each round, and the most important technical and tactical characteristics of table tennis match are often reflected in the last batting technique. These characteristics provide favorable conditions for the development and implementation of table tennis game tactics analysis system.

The formation process of each score in table tennis matches is composed of several technical movements. The combination of different technical movements forms various tactical routines. In the competition, the formulation of techniques and tactics is related to the tactics adopted by the opponents, so an excellent athlete should formulate a variety of techniques and tactics routines in the course of the competition. These routines are used alternately in the competition to form various tactical changes. The success rate of the game is related to the success rate of technical action (state reliability) and technical action conversion, that is, the success rate of tactics (state transition probability). From a statistical point of view, the success rate of technical movements of high-level athletes presents a relative stability, and the adjustment of tactics is the key to win the competition, so the analysis of tactics is particularly important.

After collecting the original table tennis game data by video technology, it is necessary to input it into the wireless sensor networks data resource management platform for storage and visual analysis for coaches to make adjustments on the spot. Therefore, the intelligent table tennis technology analysis platform is composed of data collector, data storage, and coaches, as shown in Figure 5.

Intelligent analysis platform is composed of data collector, data memory, and coach. The data collector is used to collect the technical and tactical data of the game. The collection methods are video camera and camera. Data memory is responsible for the comprehensive storage and simple statistical analysis of the collected technical and tactical data. Coaches collect technical and tactical data of matches and inquire the results of various statistical analysis.

The rotation speed and running speed of table tennis are the key factors affecting the winning or losing of table tennis matches and the accuracy. In order to quickly and intuitively analyze the competition techniques of athletes, it is necessary to calculate the rotation speed and running speed of table tennis matches, so as to provide competition guidance for athletes and coaches. The video acquisition technology mentioned above is used to collect the swing action, the trajectory, and the landing position of the players in the competition. The running speed, the trajectory, and the rotating speed of the table tennis ball are calculated. The real-time input device is put into the general resource management platform of the wireless sensor networks for storage, and the table tennis competition database...
of wireless sensor networks platform, and the interconnection between them cannot be formed. The general resource management platform of the wireless sensor networks is applied to the technical analysis of intelligent table tennis, and a tactical resource management platform for table tennis is formed, as shown in Figure 6. Intelligent Table Tennis Tactical Resource Management Platform mainly involves the modeling and control of swing action, ball trajectory, ball landing position, and base station. Based on the real-time data synchronization ability provided by the platform, it forms the sharing of players’ actual combat
information, which enables coaches to respond to players’ on-the-spot technology in time, in order to adjust and optimize players’ combat in time. Skills and tactics, and then improve the probability of winning in exchange for sports.

Based on the wireless sensor networks platform, the unified control of all heterogeneous devices under the intelligent analysis of table tennis technology can be constructed without the need to control each device. At the same time, due to the unified representation of data, direct interaction between different devices and applications can be carried out without additional conversion work. Video acquisition and data script acquisition are seamlessly integrated. Video technology is used to capture pictures and speed calculation, input them into the wireless sensor networks data resource management platform, build table tennis match database, and realize real-time updating of table tennis match parameters and calling historical data at any time. However, in order to realize the dynamic analysis of the technical and tactical characteristics of players and opponents in table tennis matches, real-time processing of the data stored in the data resource platform of the wireless sensor networks is also needed. Therefore, it is necessary to build a data mining model for tactical analysis of table tennis matches to digitally analyze the situation on the court, so that the coaches team can quickly analyze and adjust the situation on the court based on the results of digitalized analysis.

**Table tennis match tactical analysis system based on data mining technology**

By constructing a data acquisition and processing platform based on wireless sensor networks technology, the parameters and other information of table tennis matches are continuously updated, which provides a big data basis for us to study the improvement methods of table tennis technology. Analyzing the contents of table tennis database efficiently and quickly, and guiding table tennis players dynamically in real time, which have a certain guiding effect on their competitive strategy and training techniques. Therefore, we introduce data mining technology to further realize the construction of table tennis match analysis system.

**Basic principles of data mining**

Data mining appeared in the 1980s. It is used to access and query commercial databases on computers. At the same time, it can analyze and feedback the internal relations, effective information and development trends of commercial data to users. In recent years, the core modules of data mining have been expanded to mathematical statistics, machine learning, and artificial intelligence with the continuous updating of information technology. At the same time, its application fields have also infiltrated from traditional commerce to telecommunications, banking, insurance, e-commerce, taxation, police, and medical fields. The real-time data generated in e-commerce and medical fields are updated rapidly and in large quantities. Therefore, data mining has a huge development space in its field at present.

Data mining is an interdisciplinary subject, which has integrated many fields such as database technology, machine learning, statistics, pattern recognition, and artificial intelligence. There are conceptual differences between data mining and knowledge discovery, data warehouse, online analysis of information processing, and so on. But its expanded content already involves these aspects, for example, data mining is also called knowledge discovery in database. As shown in Figure 7, the specific process of knowledge discovery is introduced.

The basic concept of data mining is the process of extracting hidden, unknown, but potentially useful information and knowledge from a large number of incomplete, noisy, fuzzy, and random data. From the perspective of the database, data mining is a non-trivial
process of extracting effective, novel, relevant, and ultimately understandable information from the data provided by the database. The main research contents of data mining can be divided into two directions, one is description direction and the other is prediction direction. The specific development direction and common data mining methods are shown in Table 2.

Among the commonly used algorithms of data mining, the association rule analysis and feedback the correlation among different items in the same event. The algorithm is proposed by Agrawal and colleagues, its core content is to use the results of the last scan of the database as candidate data sets for the next scan, so as to improve the scan rate of the algorithm. Markov process is a typical stochastic process. In the process of communication, radar detection, seismic detection, reaction process, signal transmission and reception process in chemistry, mono- and diatomic photon cascade process in physics, autocatalytic reaction has a wide range of applications, including electron-photon cascade process in physics, autocatalytic reaction of chemical reaction kinetics, mono- and diatomic reaction process, signal transmission and reception process in communication, radar detection, seismic detection, and so on. The idea of data mining based on Markov process is to regard the mining object as a system composed of multiple states, and the transition process conforms to Markov process. In the process of data mining, clustering analysis is one of the main methods commonly used, it belongs to unsupervised learning. K-Means dynamic clustering, hierarchical clustering, and DBSCAN algorithm are important data mining methods for clustering analysis. As clustering analysis can be interdisciplinary, cross-domain, and cross-media, it can be used as a basic and universal method for data-intensive science. It has strong adaptability in dealing with high-dimensional data and clusters of arbitrary shapes at the same time. For other algorithms, support vector machine (SVM) has the sensitivity of selecting parameters and kernel functions, as well as the limitation of data parameters. K-nearest neighbor algorithm has the disadvantage of high complexity in computing kernel space. Therefore, aiming at the problem of data mining in the large database of the wireless sensor networks platform, this article uses cluster analysis to study the tactical data in table tennis matches.

### Table 2. Research contents and methods of data mining.

| Serial number | Research contents | Research method       |
|---------------|-------------------|-----------------------|
| 1             | Classification    | Fuzzy computation     |
| 2             | Sequential        | Rough set theory      |
| 3             | Association       | Cloud theory          |
| 4             | Clustering        | Neural network        |
| 5             | Deviation         | Legacy algorithm      |
| 6             | Regression        | Data induction        |

Cluster analysis is to divide a group of data into several categories according to similarity and difference, which makes the same category the data have stronger similarity and the different categories the data have weaker similarity. In the early 1980s, Michalski put forward the concept clustering technology, the core content of which is to specifically describe the connotation and attributes of categories in addition to considering the distance conditions among objects.

The data types used for cluster analysis can be divided into Boolean, Nominal, Ordinal, Interval scale, and Proportional scale. The matrix formula with data structure is

\[
\begin{pmatrix}
 x_{11} & x_{12} & \cdots & x_{1p} \\
 x_{21} & x_{22} & \cdots & x_{2p} \\
 \cdots & \cdots & \cdots & \cdots \\
 x_{n1} & x_{n2} & \cdots & x_{np}
\end{pmatrix}
\]  

(1)

\[
\begin{pmatrix}
 0 \\
 d(2,1) & 0 \\
 \cdots & \cdots & \cdots \\
 d(n,1) & n(n,2) & \cdots & 0
\end{pmatrix}
\]  

(2)

Formula (1) represents a data matrix, and Formula (2) represents a dissimilarity matrix. The distance between the processing objects is calculated using the corresponding function, and the distance function shall meet the following conditions

a. \[\|x_i - x_j\| = 0, \text{ that is, only if}\]

b. \[\|x_i - x_j\| \geq 0, \text{ that is, non-negative}\]

c. \[\|x_i - x_j\| = \|x_j - x_i\|, \text{ that is, symmetry}\]

d. \[\|x_i - x_k\| \leq \|x_i - x_j\| + \|x_j - x_k\|, \text{ that is, the triangle inequality}\]

In the common methods of clustering analysis, K-Means algorithm belongs to the classification method class. The K represents the number of categories in the database, and the Means represents the mean value of all data. Its principle is to cluster the initial data points through the mean value. In the process of data mining, the number K of initial categories is first determined, and the value also indicates that it should be the initial value. The determination of the value can be specified manually or calculated by hierarchical clustering. The second is to find the rest value which is close to the
The objective function is minimized by iterative positioning. \[ J = \sum_{i=1}^{n} \sum_{j=1}^{n} d_{ij}(x_j, m_i) \] (4)

Euclidean distance formula is used to calculate the distance between samples

\[ d_{ij}(x_j, m_i) = \sqrt{(x_j - m_i)^T(x_j - m_i)} \] (5)

The objective function \( J \) represents the sum of squares of distances from the initial value, that is, the minimum mean square error value. Minimizing the objective function means that no new initial value appeared to replace the previous initial value. It indicates the end of the clustering operation.

The basic steps of hierarchical clustering algorithm are as follows: first, each data point in the database is treated as a category separately, then the distance between categories is calculated, and finally, according to the calculated value of distance, pairs are connected from small to large. This process requires many iteration cycles, and the tree structure is obtained.

DBSCAN algorithm is a density clustering method based on high-density connected regions. The algorithm can divide regions with enough high density into categories. At the same time, it can find demand target data points in the database. The domain shape of the points is determined by the distance function between the two points. The basic step of the algorithm is to set an initial value, and the area within the radius of the value \( \varepsilon \) is called \( \varepsilon \)-neighborhood. If the given initial value of the \( \varepsilon \)-neighborhood contains at least the minimum number of MinPts data points, the initial value is called the core object. In a data set, if the \( \varepsilon \)-neighborhood of \( m \) contains \( n \), then the relation between \( m \) and \( n \) belongs to the direct density reachable relation. In an object chain \( p_1, p_2, \ldots, p_n, n = p_1, m = p_n \). Then for any \( p_i \in C, p_{i+1} \) can be expressed as being directly density accessible with respect to MinPts. If the \( \varepsilon \)-neighborhood of a point \( m \) contains more than the minimum number of MinPts data points, it is necessary to create a neighborhood as an initial value \( m \). And then continuously searching for data points with direct density from the initial value until the new initial value is not replaced.

Therefore, the cluster analysis method is determined to be the core algorithm of the data mining technology system. By combining with the table tennis video data collected by the wireless sensor networks platform and real-time data, the development rule of the competition is obtained using the data mining technology. And further prediction is realized.

**Results and discussion**

**Data acquisition and storage**

Video technology analysis and statistics used the data collected from two table tennis matches, about 300 games of technical and tactical records. If we use the traditional manual dragging or fast forward and fast backward way to watch the statistics of special game technical and tactical video, it should be said that it is very difficult to achieve. If we use the video fast positioning technology introduced above, it can be easily realized, and the experiment shows that its robustness and accuracy are very good. Specific operation is first use the "table tennis game on-the-spot technical and tactical analysis system" to query the required technical and tactical data, and then use our video fast positioning software to obtain the queried data for fast and accurate positioning. As shown in Figure 8, a video of a men’s singles match in a table tennis Open. Coaches can carry out fast and intuitive visual analysis and statistics of special competition techniques and tactics as shown in Figure 9.

In the course of table tennis match, the rhythm is very fast, and the data collected on the spot are often incomplete. This article presents the implementation of the corresponding post-race additional acquisition technology, which uses the method of modifying the system clock. The game time stored in the database during video acquisition is used to reset the system clock and conduct on-site analog acquisition. The collected data...
are cleaned by the built-in algorithm of the wireless sensor networks platform. The detection time of high-speed camera acquisition object is counted below.

If there are errors in the calculation of rotation speed, it is mainly caused by the frame rate, illumination, and object detection set by the camera taking pictures. The algorithm in this article is calculated by detecting the rotation of the table tennis icon for 1 week. Ideally, when the first frame and the last frame coincide, it will rotate for 1 week. In the actual calculation, due to the camera taking pictures, the relative position of the icons on the table tennis ball in the first and last frames of the detected pictures will be slightly offset. Here, using the nearest frame to the first frame as the last frame, the actual rotation speed at one frame rate is shown in Table 3 below.

Because the camera is affected by the shooting environment during the shooting process, the detected speed of movement and rotation of table tennis ball deviates from the actual situation. In this article, the actual motion speed and rotation speed of table tennis are measured and compared with the camera shooting speed.

It can be seen from Figures 10 and 11 that there are some errors in the detected velocity of motion and rotation. But the overall error will not exceed 05%, which accords with the calculation accuracy and can be used for the next calculation.

### Table 3. Calculation results of running speed and rotating speed.

| Shooting style | Total test press hard (s) | Number of frames in a rotation cycle (frame) | Running speed (m/s) | Rotation speed (r/s) | Real rotation speed interval (r/s) |
|---------------|--------------------------|---------------------------------------------|--------------------|---------------------|----------------------------------|
| Return        | 16.547262                | 58                                          | 14.383             | 108.38              | (105, 115)                       |
| Serve         | 19.406239                | 77                                          | 8.522              | 74.45               | (70, 80)                         |

**Figure 9.** Video capture object and detection time.

**Figure 10.** Comparison of actual and detected motion velocities.

**Table tennis match data mining**

**Data preparation.** Before clustering, we first need to preprocess the original data in the database of game tactics scripts. Data preprocessing is an important step in data mining. Especially in data mining with noisy and incomplete data, data preprocessing is needed to improve the quality of data mining objects, and
ultimately to improve the quality of pattern knowledge acquired by data mining.

Because the script input of table tennis match is carried out artificially, it is unavoidable that errors occur in the process of data input. First, the original data are cleaned to remove incomplete data in the original script database. Incomplete data means that the attributes of interest have no value. In the technical and tactical analysis of table tennis matches, the attributes of interest include the types of technical and tactical actions of the ball, the receiving, and the scoring.

**Data conversion.** Data conversion mainly carries on the standardization operation to the data. Because the data used in the clustering algorithm are numeric, and the data in the table tennis script database are all character data representing the technical and tactical types, so we need to standardize the digging before clustering.

Based on the state of table tennis technical movements: serve (F), swing (B), fast belt (D), attack (G), arc (H), push (T), and success. Then, the statistical state transition probability jump is the transition probability of the following states:

- Serve to swing short (F → B), serve to fast band (F → D), serve to attack (F → G), serve to push block (F → T), swing short to fast band (B → D), swing short to attack (B → G), swing short to arc circle (B → H), swing short to push block (B → T), swing short to swing (D → B), fast to attack (D → G), fast to arc circle (D → H), fast to push to block (D → T), attack to swing short to swing (G → T).

The processing methods of data conversion are as follows: backhand (F) is replaced by 0, swing (B) by 1, fast band (D) by 2, attack (G) by 3, arc (H) by 4, push-off (T) by 5. In this way, the character data in the original game script database are converted into numerical data that can be used for clustering. The conversion results are shown in Table 4.

**Data mining.**

Step 1: Scan the database once, calculate the count value of each item and save it in the set F of frequent items. The minimum support is set to 3. Select the items with support degree greater than 3 in F and arrange them in descending order. Put the results into list L. At this time, $L = \{(FC:4), (ZB:4), (FH:3), (FT:3), (ZG:3), (ZG:3), (ZG:3)\}$.

Step 2: Create a root node labeled “null” and start the second scan of the database. Frequent items in this data object have been sorted in the order in L. From n data objects, K objects are randomly selected as initial clustering centers. The clustering results are as follows:

In Figure 12, red represents the clustering results of the first category, while other colors represent the clustering results of the second category. “*” represents a side-down motion; “□” and “■” respectively, represent push and block and loop action; “○” and “●” represent lateral backspin and backspin, respectively. As can be seen from Figure 12, the two clustering results are as follows: Cluster 1: Underspin, Swing, Arc; Cluster 2: Side Down Spin, Push Block, and Attack. The results show that the cohesion of the two groups of movements is relatively high, that is to say, the frequency of combination of the two groups of technical movements in the round is higher than that of other combination of technical movements. It can be seen that compared with the k-nearest neighbor algorithm, the computational kernel space complexity is high, and the clustering analysis algorithm can effectively process the high-dimensional data, with universality.

**Conclusion**

At present, the application of computer technology in sports mainly includes management system, information release system, technical and tactical statistical analysis system, and so on. The application of sports calculation is very few, and the application of table tennis techniques and tactics is very rare. In this article, the application of video technology and data mining technology in table tennis matches under the wireless...
sensor networks environment is mainly studied based on the current research situation at home and abroad and the knowledge of related disciplines, and the following conclusions are drawn:

1. It is feasible to apply video technology and moving object detection technology to the analysis and statistics of table tennis game, which makes full preparations for the later algorithm research.
2. The wireless sensor networks (IoT) has the characteristics of efficient data processing and dynamic data analysis, which makes it possible to process data in time in changeable table tennis matches.
3. Through data mining technology in simulation, we can see that in table tennis matches, the combination of underspin, swing, and arc is used very frequently, so we should take more precautions in matches.
4. Although the scheme proposed in this article can significantly improve the utilization rate of data related to table tennis matches, the implementation process is somewhat complicated. In the future, the research should focus on the processing speed of data and improve the mining performance of real-time analysis of match data.

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