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DESIGN OF A MONITORING AND FEEDBACK SYSTEM FOR ATHLETE TRAINING PROCESS BASED ON MOBILE INTELLIGENT DEVICES

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Abstract. In order to solve the problem of high probability of information loss in traditional sports training information management systems, the authors propose the design of an athlete training process monitoring and feedback system based on mobile intelligent devices. The system improves the design of sports training information mobile storage servers, mobile information collection sub sites, and intelligent information processors in terms of hardware, and processes users' sports training information in real-time. In terms of software design, classify the sports training information of different users, calculate the similarity of sports training information of different users, and complete intelligent information management. The experimental results show that for traditional information management systems, the average packet loss rate for tablet device users is 0.0534%, and the average packet loss rate for mobile device users is 0.0732%. The data on packet loss rate is relatively high. For the intelligent management system of sports training information based on mobile devices, the average packet loss rate for tablet users is 0.0144%, and the average packet loss rate for mobile device users is 0.0300%. By comparison, it can be seen that the packet loss rate of information intelligent management systems based on mobile devices is lower. The information processing packet loss rate of this system is significantly reduced, which is better than traditional information management systems.

Key words: Sports training, Information management, Mobile devices

1. Introduction. Modern training theory believes that the training process of athletes is a systematic engineering process that combines multiple disciplines and factors to achieve the best combination [1]. Therefore, in order to grasp the process of athletes' competitive career, it is necessary to have a clear understanding of the growth process of athletes and the conditions under which the athlete training system was formed and evolved. This is one of the important prerequisites for athletes to move towards "scientific" long-term systematic training [2].

From the perspective of training theory, the excellent competitive ability of athletes is the foundation and prerequisite for achieving excellent sports results, which has attracted great attention from training management departments and research institutions at all levels to the competitive ability of athletes. Especially in some individual projects, the benefits of the training system can be demonstrated through the individual performance of athletes. Therefore, the training system needs to revolve around the best individual competitive ability of athletes [3]. In addition, for some excellent athletes who have already formed stable competitive abilities, how to maintain their stable development of competitive abilities and delay decline is also a problem that needs to be solved [4]. With the rapid improvement of athletic performance, the increasingly fierce competition in large-scale competitions has put forward higher requirements for the competitive ability of athletes. In order to enable athletes to compete for a place in high-level competitions, it is necessary to pay attention to how the athlete training system can be improved and evolved. Therefore, understanding the mechanism of the evolution of the athlete training system has high theoretical value [5]. The growth process of athletes is a continuous and complete time process, and the ultimate goal of athlete training is to achieve the ideal state of the athlete's organism to ensure the achievement of high-level sports results. Therefore, timely capturing and grasping the characteristics of different stages in the athlete training system and making reasonable diagnoses of the athlete's competitive ability status is of great guiding significance for coaches, athletes, medical supervisors, scientific researchers, administrative managers, and all participants in the training process [6].

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2. Literature Review. The core of the athlete training system is to improve competitive ability. The evolution of competitive ability is one of the most significant characteristics reflecting the athlete training system [7]. The process of sports training is a gradual development of an athlete's competitive ability, as well as a process of promoting the gradual evolution of the athlete from the initial state to the target state. Each training stage is a continuation of the previous training stage and also the foundation of the subsequent training stage. The training stages at different levels constitute the entire competitive development process of athletes through a certain sequential arrangement and combination. Mou, Y. et al. mainly studied the application of embedded system technology in sports training and mobile interconnection control systems for bicycle equipment [8-9]. Tan, L. et al. proposed a mobile artificial intelligence terminal technology and developed and designed an athlete training process monitoring system based on C/S mode. GPS is used to obtain real-time location information of athletes and provide real-time guidance for them [10]. Nie et al. proposed a motion perception system using multi-agent technology in motion training. In the study, the relevant concepts and methods of agents were introduced in detail. In order to better simulate the changes in human joints during movement, various comparison methods were adopted. Among them, the experiment of the imaging analysis module was conducted through simulation of the simulation system. The experimental results indicate that the role of multi-agent in simulation systems is enormous [11].

Intelligent management of sports information generated in sports training venues such as schools, gyms, and gyms can further improve the management efficiency of the sports training process. At present, the management of sports training information is mainly manual, supplemented by simple computer management. Although it can reduce workload, it has not fundamentally changed, and there is still a lot of room for improvement. Based on this, in order to reduce the workload of manual management, the author proposes an intelligent management system for sports training information based on mobile devices.

3. Method.

3.1. Sports training information mobile storage server. The management system designed by the author includes two types of servers: One is a real-time information storage and collection server, and the other is a historical information storage and processing server. The author selected the Weifu COP2000 computer as the core platform and arranged it with various unit components in a structural model [12]. When the concurrency is less than 100, the server's built-in RAID card can be used to connect the hard disk; When the concurrency exceeds 100, it is necessary to configure the hard disk as a hardware disk array and use fiber channel storage to achieve high-performance information storage. The structure of the mobile storage server is shown in Figure 3.1.

3.2. Mobile information collection sub sites. The sub site is the middle layer of the information management system, which communicates with the main site terminal to collect and forward telemetry and remote adjustment data. The mobile sub site designed by the author follows the sports training process in real-time, collects sports training information through monitoring components in the sub site, and transmits it to the main site [13]. Choose a CISCO2509 model router and communicate with the main site through an SDH 2M+model router. The number of mobile sub sites should be selected according to the actual needs of users, and should be able to meet the real-time data collection and transmission needs within the jurisdiction of each sub site. If some sports training venues have a large scale and require a lot of real-time recording information, two or more mobile sub sites can be equipped for the same user at the same time to ensure the smooth operation of the site.

3.3. Information intelligent processor. Intelligent processors are mainly used for collecting data and receiving external information. The information resources involved in sports training are very complex, and can only be accessed and applied after integration and processing. In the sports training information management system, the author designs an information intelligent processor with different ports on the outside of the processor, responsible for different functions. The author chooses the information intelligent processor model S3C6410, and its framework is shown in Figure 3.2.

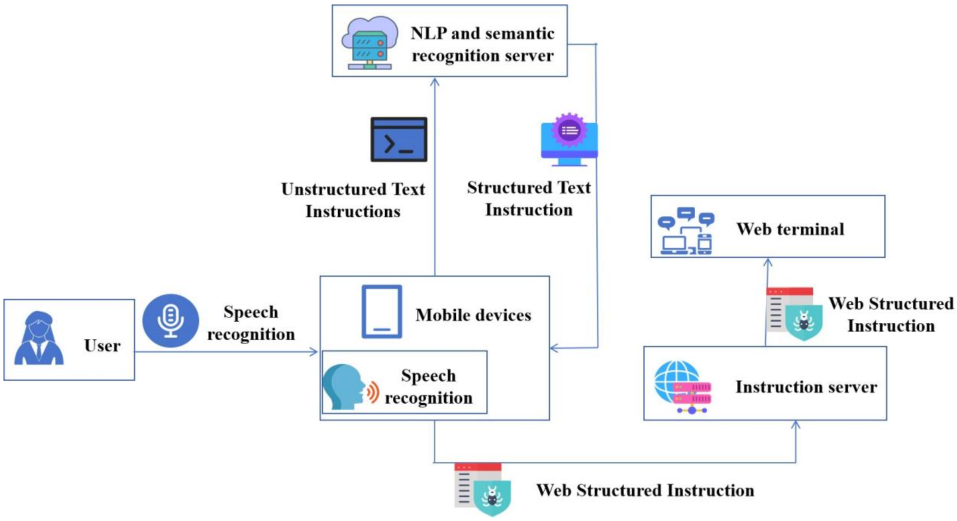

Fig. 3.1: Mobile Storage Server Structure

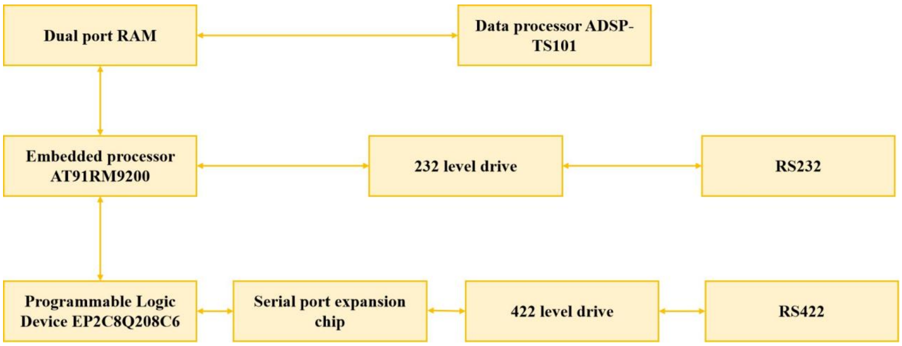

Fig. 3.2: Framework diagram of information intelligent processor composition

3.4. Software design of intelligent management system for sports training information . The receiving end of the software system needs to collect the generated sports training information in real time and classify the information preliminarily based on its characteristics [14]. The calculation formula for information category y is

$$y = \frac{1}{n}\sum_{i=1}^{n} ||t - Y|| \tag{3.1}$$

In the formula, n represents the number of sports training information features from different sources; t represents a time variable; Y represents non intersecting features in information data. All information is grouped in the form of user name and ID number, so that the user can continue to register his/her information when he/she performs sports training again. When a user inputs their information again, the system will retrieve all their past information from the background and display key information on the front-end interface [15].

Extract the sports training information stored in the system according to the different users, analyze the content similarity of the sports training information, sort all the sports training information of the user based on the time when the information is recorded, and obtain the corresponding first similar sequence [16]. Integrate the first similar sequence to obtain the second similar sequence of the user, analyze the similarity

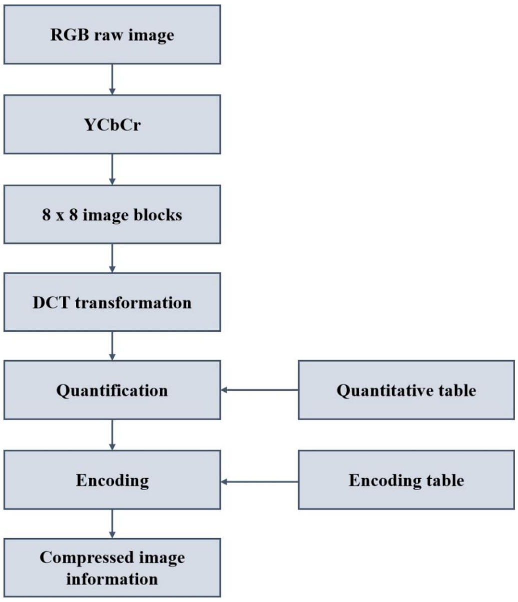

Fig. 3.3: Video monitoring and image processing of the entire process of athlete training

relationship between the first sequence and the second sequence, and each pair of sports training information with co-occurrence relationship is two pieces of information belonging to the same user [17]. Connect two pieces of information and calculate their information similarity. If the similarity between the user and training information is , the process of processing this data information can be expressed as:

$$m_A = \frac{1}{1-x} \sum_{A_m} m_i(A_m) \tag{3.2}$$

In the formula: A represents user identity; x represents the number of times information is processed; Am represents the similarity process quantity of the sports training information; represents an orthogonal set of data information. The calculated result is the final information similarity of the user. By calculating the data information similarity for information processing, intelligent management of sports training information is completed.

3.5. Monitoring video collection throughout the training process. The author combines fuzzy region information fusion and block feature matching to capture video footage of the entire process of athlete training, and adopts the method of image block fusion to capture and fuse images for video monitoring of the entire process of athlete training [18]. As shown in Figure 3.3:

The author used a grouped packet detection method to analyze the ambiguity of the entire training process video monitoring. Based on the regional distributed fusion method, the edge contour feature points of the athlete training process video images were analyzed, and the three-dimensional pixel distribution set for the entire training process monitoring was obtained as follows:

$$T' = \frac{\partial \phi}{\partial t(1-\theta)} \sum_{i=1} (\lambda_i e_i^{LBF} - \mu \lambda_i e_i^{LGF}) \tag{3.3}$$

Among them, ∂, θ, ϕ represents the three-dimensional pixel distribution parameter, λ_i represents the spatial distribution set vector, and e_i^{LHF}, e_i^{LCF} represents the correlation degree of the spatial distribution area in the athlete training video. The expression is as follows:

$$e_i^{LBF} = \int_{\Omega} \lambda_i (y-x) |f(x) - f_i(x)|^2 dx \tag{3.4}$$

$$e_i^{LGF} = \int_{\Omega} \lambda_i(y-x)|f(y)-f_i(x)|^2 dy \tag{3.5}$$

The author combines three-dimensional pixel distribution and corner feature information distribution to perform trajectory tracking and classification detection throughout the training process [19]. Through the collection of three-dimensional information from the video images of the entire athlete training process, assuming a two-dimensional image is I (x, y), the monitoring video acquisition model obtained by using Gaussian search function (DOG) is:

$$G(x,y,\sigma) = \frac{1}{2\pi\sigma^2} e^{-1} + (x^2+y^2)/2\sigma^2 \tag{3.6}$$

$$L(x,y,\sigma) = G(x,y,\sigma) \times \frac{I(x,y)}{e^2} \tag{3.7}$$

Among them, σ is the scale space factor, which is used for video image fusion processing throughout the training process.

3.6. Video surveillance feature extraction. With the development of machine vision information recognition technology, the author adopts image vision monitoring recognition method to monitor the entire training process of high-level swimmers. Using optimized image processing technology, a video monitoring and image analysis model for the entire training process under machine vision is established. By sampling video features and extracting information from images throughout the training process, combined with motion video tracking recognition, the ability to monitor and analyze the entire training process of high-level swimmers is improved, which is of great significance for promoting the improvement of swimming training level. Based on the results of video monitoring, collection, and fusion processing obtained from the entire process of athlete training, an RGB feature decomposition model of the video image is established. By calculating the RGB feature space components of the entire training process video, the RGB feature transformation relationship of the athlete training process video is obtained:

$$Y = \sum_{x \neq y} C_x + C_y - \frac{1}{2} \tag{3.8}$$

In the formula, C represents the RGB spatial component, and x and y represent the spatial distribution coordinates. Perform lossless transformation and feature compression on the RGB images of the entire training process video of athletes, and obtain the transformation formula:

$$F(x,y) = \frac{C_x C_y}{8} [\int_{x,y=0} (cos\frac{(2x+1)xy\pi}{16})^2 dx] \tag{3.9}$$

Among them, (x, y) is the image coordinate point.

Assuming that the spatial state feature distribution set of the entire training process video image of athletes follows a normal distribution, that is $n \in N(0, \sigma_n^2)$, where σ_n^2 is the matching feature point of the entire training process video image, the feature variable analysis function of the athlete training video image is obtained [20]. Its expression is:

$$X = \sigma_n^2 \sqrt{\frac{x_{i0} - y_{i0}}{\delta_i} + T' \sum_{i=1} F(x,y) + 1} \tag{3.10}$$

Among them, T' represents the fusion amount of video surveillance throughout the training process, and δ_i represents the entire training process.

The author conducted information monitoring and recognition on the collected video images of the entire training process, and obtained feature variable analysis results through the above analysis. Combined with statistical classification methods, key feature points of high-level athlete training video images were extracted for image classification and recognition.

The process of extracting features from video surveillance images is shown in Figure 3.4.

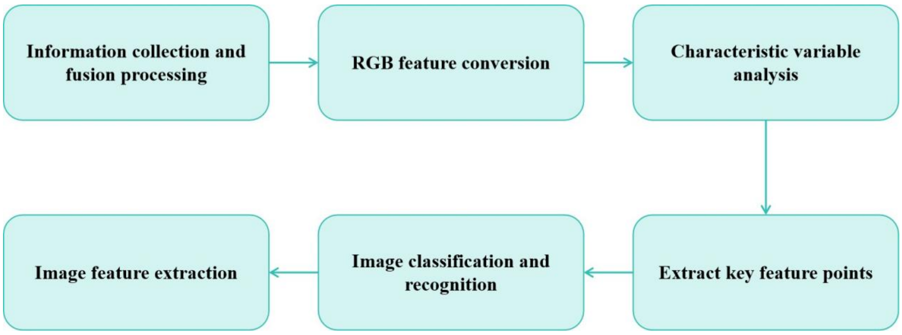

Fig. 3.4: Feature extraction process for video surveillance

3.7. Training 3D Reconstruction. Based on the information recognition of athlete training video action images, combined with the key action feature point extraction model of the entire training process video images, the partition block matching function is obtained as follows:

$$\widetilde{t}(x) = 1 - min_{y \in \Omega(x)}(\frac{I^C(y)}{A^C}) \tag{3.11}$$

Among them, $I^C(y)$ represents the local trajectory of the video monitoring of the entire process of athlete training, and A^c represents the scale information of the video image of the entire process of athlete training.

By using the method of local ambiguity detection, a parameter information analysis model for the entire process of athlete training video images is established, which is expressed as:

$$d(x,y) = \sum_{i=1} d_i(x+1,y) + d_i(x-1,y) + \frac{d_i(x,y+1)}{d_i(x,y-1)} \tag{3.12}$$

In the formula, x and y represent the three-dimensional parameters of image information.

By combining the method of calculating fuzzy frame difference sequences, the three-dimensional decomposition of athlete training action feature points is carried out to obtain the three-dimensional distribution function of the training action trajectory, which is described as:

$$\theta(x,y) = d(x,y) + \sqrt{\frac{L(x-1,y)}{L(x,y+1)} - 1} \tag{3.13}$$

Among them, L represents the fuzzy frame difference sequence coefficients and.

Based on the above analysis, combined with the distribution characteristics of video images, a three-dimensional reconstruction model of athlete training actions is established, which is expressed as:

$$G(x,y,t) = r * \frac{n}{u(x,y,t)} + \sqrt{u(x,y,t)+1} \tag{3.14}$$

Among them, r represents the three-dimensional sequence path ratio of video images, and n represents the distribution feature coefficient of video images.

In summary, a three-dimensional reconstruction model of athlete training actions was obtained, and the training action information was fused based on the three-dimensional reconstruction results.

Based on the three-dimensional reconstruction model of athlete training actions, a fusion matrix of training action information is obtained. Combined with the local fusion degree of video images throughout the training process, a video tracking function is constructed for the entire training process, which is expressed as:

$$H = G(x,y,t) + \sum_{i=1} \frac{L(x,y,t) + u(x,y,t)}{2r} - 1 \tag{3.15}$$

Table 3.1: Parameters of Test Equipment

The name of the parameter	ipad	mobile phone
Memory/GB	4	4
storage/GB	128	128
Running memory/GB	8+128	8+128
operating system	Android	Android

Table 4.1: Comparison Results of Packet Loss Rate

Equipment serial number	The packet loss rate of traditional information management systems/%	Packet loss rate/% of information intelligent management system based on mobile devices
Tablet 1	0.040	0.015
Tablet 2	0.061	0.021
Tablet 3	0.052	0.011
Tablet 4	0.045	0.012
Tablet 5	0.063	0.010
Mobile phone 1	0.074	0.023
Mobile phone 2	0.064	0.031
Mobile phone 3	0.075	0.021
Mobile phone 4	0.081	0.034
Mobile phone 5	0.066	0.033

Based on the above analysis, the trajectory recognition of the entire training process for high-level athletes is:

$$p(x,t) = \lim_{\Delta x \to 0}[\frac{\sigma^{\Delta x}}{\Delta x} * (u + \Delta u)] - p(\omega_i) \tag{3.16}$$

Among them, Δu is the associated pixel point for global threshold segmentation of the entire training process video image, σ is the gray feature of the entire training process video image, and $p(\omega_i)$ is the edge feature distribution set for tracking and recognition of the entire training process video.

3.8. System testing. Prepare 10 mobile devices with the same configuration, 5 tablets and 5 phones each. To ensure the smooth progress of the experiment, a comparison was made between traditional information management methods and the author's proposed intelligent management system for sports training information based on mobile devices. The parameters of the testing equipment are shown in Table 3.1.

4. Results and Discussion. Tablets and mobile phones were tested separately to receive sports training information from 2000 resource packets and record the number of lost packets. The experiment was repeated three times, and the average of the three experiments was taken to calculate the system packet loss rate. The results are shown in Table 4.1. According to the data in Table 4.1, after calculation, it can be concluded that for traditional information management systems, the average packet loss rate for tablet device users is 0.0534%, and the average packet loss rate for mobile device users is 0.0732%. The data on packet loss rate is relatively high; For the intelligent management system of sports training information based on mobile devices, the average packet loss rate for tablet users is 0.0144%, and the average packet loss rate for mobile device users is 0.0300%. By comparison, it can be seen that the packet loss rate of information intelligent management systems based on mobile devices is lower. It can be seen that the intelligent management system for sports training information based on mobile devices is more comprehensive in collecting and processing user data information, and can adapt to different groups of people.

5. Conclusion. The author proposes the design of an athlete training process monitoring and feedback system based on mobile intelligent devices. In response to the problem of incomplete sports training information management, the author proposes an intelligent sports training information management system based on mobile devices. Compared with traditional information management systems, this system significantly reduces packet loss rate and can comprehensively record user sports training data information, providing scientific guidance for intelligent management of sports training information.

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