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Research on physiological plan system of real-time acquisition and analysis of athletes physiological data in badminton training

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ABSTRACT

Along with the rapid promotion of badminton skills under a new trend, competition rules, and requirements for the athletes are also increased. This study mainly studies the real-time acquisition and analysis of athletes' physiological data in badminton training, to make valid training plan based on the actual situation of athletes, thus to set solid foundation for their further development. As badminton is a flexible activity, and requires coordination of various parts of the body to play their best, it can not only exercise the body, but also enhance the character. But in the study, there are many problems in badminton training to solve. To settle these problems, the Physiological Plan system is designed composing four levels, namely hardware, algorithm, interfaces, and data processing. These four levels are closely related. After a series of operation, the processed result will be presented to the coaches, which is the key of this study. The research focuses on studying Physiological Plan system for real-time capture and analysis of physiological data during the training, finding a fundamental solution to the current problems in the badminton training, so as to create conditions for coaches know more accurately about the state of badminton athletes in training and competitions. Staring from the development of Physiological Plan system, this study aims to research on the system working on athletes' real-time acquisition and analysis of physiological data in the badminton training, in order to provide powerful theoretical support for the majority of researchers.

KEYWORDS

Badminton training; Real-time acquisition and analysis; Physiological data.

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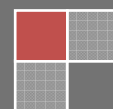
INTRODUCTION

Under the background of models based on physiological computing, there is no need for users to type the information into the system for the system can realize real-time acquisition and analysis of physiological data through physiological and perceptual equipments, and analyze users' physiological state accordingly, and physiological state after a series of conversion can send the physiological data as feedback to users. Physiological calculation is an innovation on the past ways of calculation, offering a new way for users to know about their physiological state, and directing the forward of human-computer interaction. Of course opportunities and challenge coexist. In order to apply this system in badminton training or other fields, the problems should be settled first, for example, physiological and psychology theories research and actual application, physiological signal processing algorithm, and physiological calculation software tool. The study takes the real-time acquisition and analysis of physiological data as a hot issue, to lay a solid foundation for scientific and systematic training plan making.

SYSTEM FOR REAL-TIME ACQUISITION AND ANALYSIS OF ATHLETES' PHYSIOLOGICAL DATA

In sports field, athletes are required to master excellent professional skills, and coaches need to know well about athletes' states in competition and physiological status in training. Only by solving the external factors on badminton athletes fundamentally can their skills be performed to the maximum level. And this will provide conditions for educators to make scientific training plan, and to improve their skills in a scheduled way. During the competition, spot strategy can be made according to athletes' onsite performance[1]. At present, optical sensors such as cameras and inertial sensors such as gyroscopes have been the important ways for real-time acquisition and analysis of physiological data in badminton training. The application of these technologies is helpful in assisting coaches to analyze athletes' physiological movement status and physical movement status, such as running distance, physical coordinative skills, and smash and other movements. Athletes' physiological movement status can be felt but not perceived[2]. As far as the current developments, physiological data has been used for many aspects such as training, competition, and selection of athletes, but real-time acquisition and analysis of physiological data in the badminton training is still in its early stages. The athletes' training process is shown as Figure 1.
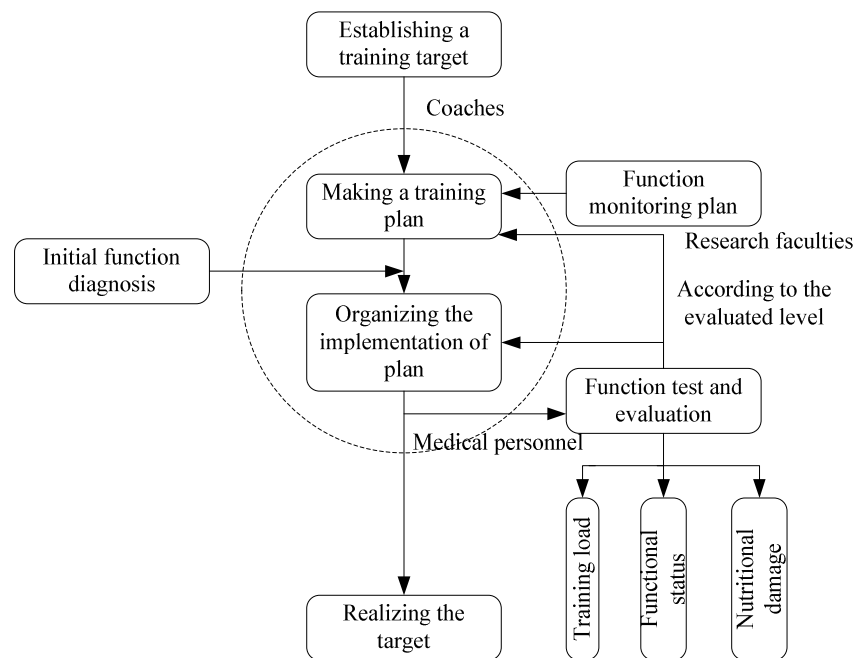

Figure 1 : Athletes' training process

As shown in the Athletes' Training Process in Figure 1, coaches establish a training target, and after several stages this target is achieved. By this way, the comprehensive ability of badminton athletes gets enhanced. Currently athletes' physiological data acquisition mainly relies on weekly or occasional blood collection, with a series of tests the athletes' physiological data comes out. Or it relies on subjective evaluation forms filled by athletes based on their memories in training and competitions. In some sense, blood testing data collection or subjective evaluation forms, all take a very long time, while the data needed is athletes' spot physiological data, such as muscle tension, heart rate or heart frequency. In addition, buzzer beaters in training and competition are all finished in one instance, factors such as degree of energy efficiency, emotions, degree of fatigue, if all rely on the perception of athletes, there won't be accurate data. In response to these emerging issues, Physiological Plan system is designed and studied. This system use Berkeley Tricorder as hardware, and in aspect of data management, adapter pattern is applied to integrate data from all sensors effectively, in aspect of algorithms, it includes

filtering algorithm, peak extraction algorithm and Outlier detection algorithm[3]. Interface layer mainly interacts with coaches and offers final results back to coaches. This system can realize a comprehensive acquisition and analysis of the athletes' physiological data, such as electrocardiogram, electromyography and 3D acceleration of athletes. The system will resent the final result to coaches, who after analyzing the status of athletes in training and competition will make training plans suitable for badminton players. And this will enhance the athletes' processional level to some degree, and lay a solid foundation for their success in the future competition.

MONITORING ALL FUNCTIONS OF ATHLETES IN BADMINTON TRAINING FOR MORE PRECISE PHYSIOLOGICAL DATA

Monitoring pattern of function in badminton training

As shown in the Schema of Functions in Sports Training in Figure 2, the aim in training badminton athletes is to master functional status of their bodies, so that they can meet the physical needs in competitions as well as a high level of adaptation with the external actions. So is the real-time acquisition and analysis of physiological data. When the athletes' physical function is enhanced, their skills will be promoted correspondingly. Therefore Physiological Plan system is designed to provide coaches valid feedback information, monitor athletes' physical function in real time, and can help coaches with a complete understanding of athletes' body status and their sports load status, thus to provide a solid theoretical basis for adjusting the previous training plan and scheduling a scientific and reasonable training programs to help the enhancement of athletes' comprehensive abilities. This monitoring pattern is conditioned on the functional status of athletes, and an important research in sports science, as well as a necessary preparation for athletes' scientific and reasonable training.
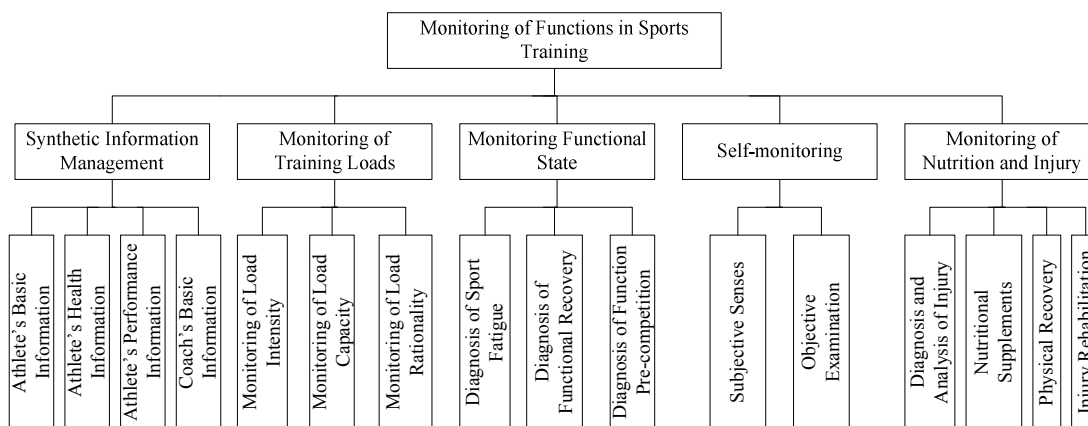

Figure 2 : Schema of functions in sports training

Physiological plan system monitors the training load while providing physiological data

As shown in the Schema of Functions in Sports Training in Figure 2, currently monitoring training load intensity is mostly done through intensive training, mainly including blood lactate, heart rate and serum CK and so on. This approach is often used in training, not limited to badminton training, also used for other trainings. Pursuant to one action in one instant, the system can acquire athletes' physiological data, as well as access to the body's ability to respond to the intensity of training, or monitor functional ability of badminton athletes in certain energy metabolism, for physical performance, in addition to skills, is the key to success in competition.

Monitoring of functional state

As shown in the Schema of Functions in Sports Training in Figure 2, during the training process, there are many factors influencing the performance of athletes' skills, mainly there are subjective factors and objective factors. Subjective factors include skill efficiency, mastery of professional knowledge, and the application of knowledge in practice. And objective factors include teaching level of coaches, application of scientific methods, and height and skill efficiency of the opponents and so on. These factors all influence athletes more or less. Athletes' physical function state monitoring is primarily aimed at cardiovascular system, immune system, nervous system, and energy metabolism. In addition, all functions return to normal when the athletes rest, by analyzing and comparing the data in break with data in movement time of heart beat and blood, even ingredients in saliva, urine, more accurate athletes' physiological data can be obtained[5].

Self-control or Self-monitoring

As shown in the Schema of Functions in Sports Training in Figure 2, the physiological data in badminton training real-time acquisition and analysis is dependent on the level of fatigue and function status, which creates the conditions for precise physiological data, with reference values should not be overlooked, and which can also lay a solid foundation for developing scientific training programs. Subjective senses mainly include mood, sleep quality, appetite and so on, while

objective examination is mainly divided into pulse, blood, weight, etc[6]. Coaches get access to athletes' physiological data through a combination of status of athletes in all aspects based on observation and the Physiological Plan system. Regarding to subjective factors, athletes should apply other assistant ways in self-monitoring process to ensure data accuracy.

Monitoring of nutrition and injury based on the real-time acquisition and analysis of athletes' physiological data

Scientific and reasonable meal plans for athletes are needed according to badminton athletes' training scheme and the intensity of training, together with the athletes' performance, to make sure the nutrients can be replenished. And according to athletes' actual needs and obtained physiological data, nutritional supplements should be offered to athletes irregularly. Furthermore, since injury in training and competitions happens now or then, coaches are required to pay special attention to the injured parts such as shoulder joint, and knee, thigh, shank and other easily injured parts according to injury features in badminton. By excluding the injury factors in competition thoroughly, the athletes can performed their skills to the maximum, and lay a solid foundation for outstanding results.

MAIN FRAMEWORK OF PHYSIOLOGICAL PLAN SYSTEM

According to what mentioned above, it can be easily found that the application of Physiological Plan system can not only obtain the real-time acquisition and analysis of athletes' physiological data, but also monitor the body function of athletes. This system is composed simply of four parts, namely hardware, data processing, algorithm layer and interface layer[7]. As shown in Figure 3 below:
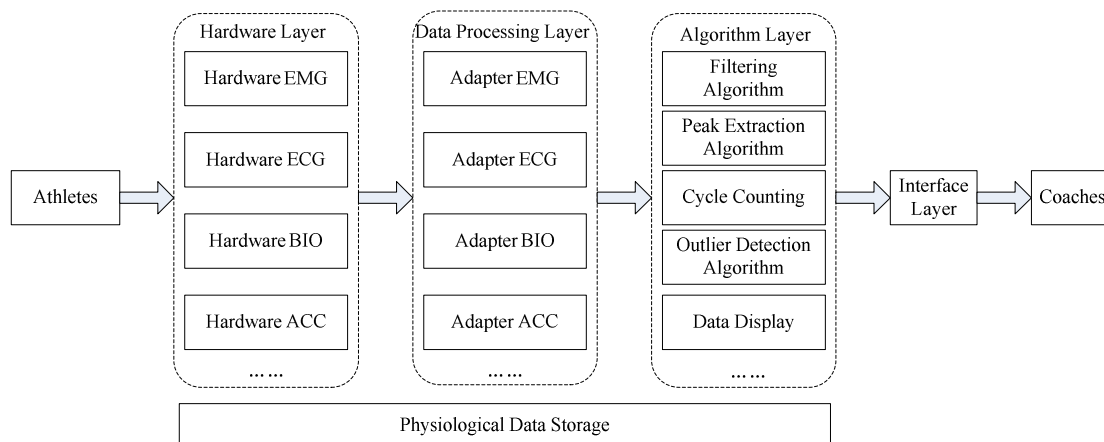

Figure 3 : Framework of physiological plan system

Hardware Layer

As can be seen from Figure 3, there are many hardware equipments in hardware layer, and each sensor has different function, but they all have one aim, that is to obtain and analyze the physiological data of athletes, for example, EMG is for electromyography, BIO is for bioimpedience and so on[8]. Research data is required according to national team training badminton players, or some of the latest data, the system is also physiological testing equipment with high degree of integrity, and thus the data concluded is relatively accurate. Berkeley Tricorder is used for acquisition of data. Due to the different ways for sensors to obtain data, and the corresponding data formats are different, a systematic classification of the data is necessary. The data processing layer directly serves the device adapters, ensuring its orderly operation. And each adapter is matched with signal acquisition device. For example, EMG is matched with a muscle signal acquisition device; ECM is matched with ECG acquisition device and so on. Although the approaches of physiological data obtained by each sensor are not the same, their function is the same in transferring all sensor data into a unified format, which provides convenience for later sorting and displaying data standing in a overall view.

Algorithm layer

As shown in Figure 3, the obtained data by hardware layer after being processed by data processing layer will be analyzed by the algorithm layer. And algorithm layer is composed mainly by five parts, namely filtering algorithm, peak extraction algorithm, cycle counting, Outlier detection algorithm, and data display. In the process of analyzing the data, all are done in order and finally present the physiological data to users for a solid foundation for scientific and reasonable training plans.

Interface layer

As shown in Figure 3, the interface layer is composed by two parts. One is to present the real-time acquisition and analysis of athletes' physiological data to coaches, and the other is accept the input data by coaches and analyze the data, based on which interact with the coaches and send the data to algorithm layer or data processing layer for an output.

Data processing layer

To unify the data formats of each sensor is the embodiment of data processing layer, which create preconditions for later convenient processing. The original input data types can be simply divided into four parts: electrocardiogram, electromyogram, bioelectrical impedance, and tri-axial acceleration. The tricorder data file format is shown as TABLE 1, the tricorder classification structure is shown as TABLE 2.

TABLE 1 : Tricorder data file format

Byte	1-2	3	4	5	6	7	8	…	510	511	512
Content	Reboot flag bits	Data type 1	High quantity data	Low quantity data	Data type 2	High quantity data	Low quantity data	…	Data type n	High quantity data	Low quantity data

TABLE 2 : Tricorder classification structure

Byte	1-2	3	4	5	6	7	8	…	510	511	512
Content	Reboot flag bits	Data type 1	High quantity data	Low quantity data	Data type 2	High quantity data	Low quantity data	…	Data type n	High quantity data	Low quantity data

As shown in TABLE 1 Tricorder Data File Format, the raw data of Tricorder is recorded by binary files, with files divided into uninterrupted continuous blocks. There are total 512 low quantity data. The first two bytes of the block tells the reboot or not of the equipment, while the other 510 bytes classify three into one group, and the first byte tells the type of the data, with the latter two represent high quantity data and low quantity data[9]. In order to make sure of the real time and accuracy of the data, the transmission frequency between the Tricorder Data and computer is kept in a range, neither too high nor too low, to avoid the affect brought by computer processing load. The Chart of ECG Changes of Athletes in Different Levels is shown as Figure 4.
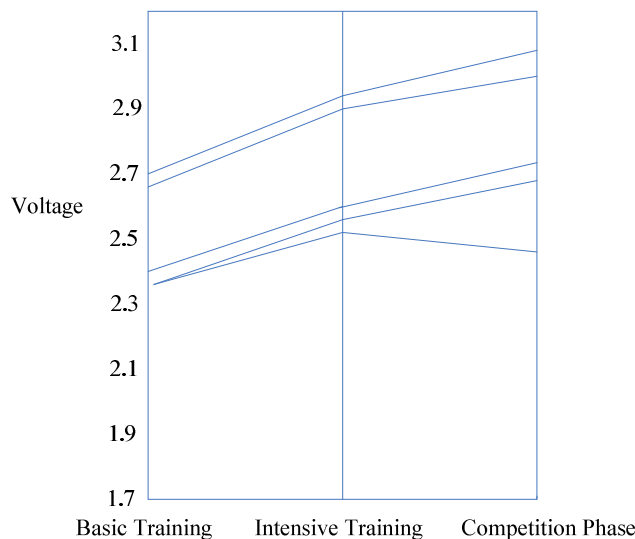

TABLE 4 : Chart of ECG changes of athletes in different levels

As shown in TABLE 4 Chart of ECG Changes of Athletes in Different Levels, in order to unify the data format from various sensors, the adapter pattern is applied considering that each sensor has a matched adapter. The transferred data can be classified into four categories: category, and time, and value and extended content. Category refers to the category of sensors such as ECG, EMG and so on. In the table above, the level of athletes is closely related with the value of ECG. For more precise data, quality of every aspect of athletes should be considered, such as sport type, skill type and power type, so as to obtain accurate physiological data and prepared for the next step. Time refers to the unchanged raw data after factors influencing, which reflects the law of sensors changing with the time.

CONCLUSION

This study starts from the design and framework of Physiological Plan system, focuses on the system of real-time acquisition and analysis of athletes' physiological data, such as function monitoring mode in badminton training,

Physiological Plan System's monitoring the training load while providing physiological data, monitoring of functional state, self-control of self-monitoring and so on. This is to provide conditions for accurate athletes' physiological data, meanwhile coaches can make scientific and reasonable training plans based on the actual situation of athletes, to exclude other factors influencing the performance of skills in competition, and lay a solid foundation for outstanding results in competitions.

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