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AI-Empowered Precision Training and Intelligent Monitoring of Athletics

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Abstract: AI-empowered athletics physical training can provide in-depth insight into the unique physical characteristics and training needs of each athlete based on massive data and accurate algorithms, and more accurately determine key parameters such as training intensity, duration, and frequency, so as to make the training more suitable for the actual situation of athletes, reduce the risk of injury and illness caused by improper training, maximize the physical potential of athletes, and achieve a significant improvement in training effect. At the same time, during the training process, the real-time monitoring and feedback mechanism of AI can allow coaches and athletes to understand the physical state and the performance of technical movements in a timely manner. If a problem is identified or deviates from the training goal, adjustments can be made quickly to ensure that the training is always on the scientific track. This ability to dynamically adjust makes the training process more flexible and efficient, and can better adapt to the individual differences of the athlete and the various factors in the training. This paper first analyzes the key application of AI in precision training of athletics from two aspects: the formulation of data-driven personalized training programs and real-time adjustment and optimization of training plans, and then expounds the intelligent monitoring of AI-enabled athletics physical training process from the aspects of physiological index monitoring and technical action monitoring and correction, and finally discusses the accurate evaluation of the effect of AI-enabled athletics physical training, aiming to provide theoretical basis and practical reference for the scientific and precise development of athletics physical training.

The key to improving the competitive level of track and field athletes is physical training. The traditional track and field physical training mode mainly relies on the rich experience of coaches and the subjective perception of athletes themselves. This training mode lacks specificity, inaccurate evaluation of training effects, and other problems, resulting in the formulation of training plans that are not scientific and reasonable. Athletes' self-awareness is also easily affected by factors such as emotions and fatigue. With the rapid development of artificial intelligence technology, the introduction of artificial intelligence into track and field physical training has brought a good opportunity for the precision and intelligence of training. With its powerful data processing capabilities, accurate analysis and prediction capabilities, and efficient decision-making capabilities, AI technology can maximize the physical potential of track and field athletes, formulate

personalized training plans for athletes, achieve precise training, and provide real-time feedback on athletes' training status through an intelligent monitoring system to improve training effectiveness and safety, thereby significantly improving the training effect and competitive level, and promoting the development of track and field physical training in a more scientific and efficient direction.

1. The key application of AI in the precision training of track and field physical fitness

(1) Formulation of data-driven personalized training programs

First of all, the AI system has powerful data collection and analysis capabilities, which can comprehensively collect a large amount of historical data of athletes in multiple dimensions. For example, physical indicators such as height, weight, body fat percentage, and muscle mass reflect the basic physical characteristics and physical fitness foundation of athletes; Past training data such as training intensity, duration, frequency, and recovery record the athlete's performance and physical adaptation at different stages of training; The results of the participating events, the technical performance of the competition, the effect of tactical use and other competition results and performance data. Through the in-depth analysis of these rich and complex multi-dimensional data, advanced machine learning algorithms are used to build athletes' physical fitness models, which can accurately predict athletes' physical reactions and physical improvement space under different training loads. [1] For example, for endurance track and field athletes, the AI system will comprehensively consider physiological indicators such as maximum oxygen uptake and lactate threshold, which are directly related to the athlete's endurance level and energy metabolism, and combine specific training data such as running speed, distance, and heart rate in the athlete's daily training to tailor a personalized endurance training plan for them. Second, when developing a training plan, the AI is able to determine the optimal training intensity range. This zone is an effective way to stimulate the athlete's physical function and promote physical improvement, while avoiding the risk of overtraining and injury caused by excessive intensity. Thirdly, AI can also accurately plan the increasing pace of training volume, and gradually increase the training volume according to the athlete's physical recover[2].

(2) Adjust and optimize the training plan in real time

In the process of athletics physical training, the athlete's physical state and training data are in a dynamic change. With its real-time monitoring and rapid analysis capabilities, AI can track changes in athletes' physical status and training data in real time. On the one hand, through wearable devices, AI can obtain key data such as athletes' heart rate, movement trajectory, and acceleration. When an athlete is detected showing signs of fatigue or training data deviating from the preset goal, the AI system will respond quickly and adjust the training plan in time. For example, if an athlete's heart rate is abnormally high and lasts for a long time during training, it means that the athlete has developed a problem with fatigue. At this point, the AI will automatically reduce the intensity of subsequent training sessions and reduce the training load, thereby avoiding further damage to the athlete's body. At the same time, the system will appropriately increase the rest time to give the athlete's body enough time to recover and adjust. [3] On the other hand, if an athlete progresses less quickly than expected at a certain stage of training, the AI will analyze the reasons in depth, either because the training content or method is not suitable for the athlete's current physical condition and fitness level, or because the training intensity or frequency needs to be adjusted. Then, based on the analysis results, the AI will appropriately adjust the training content or method, add specific strength training movements, and conduct intensive training for the athlete's weak links. Or change the sequence of training combinations to optimize the training process and improve training efficiency, thus ensuring that the training plan is always in line with the athlete's actual fitness status and training goals.

2. AI-empowered intelligent monitoring of the track and field physical training process

(1) Monitoring of physiological indicators

In the process of athletics physical training, physiological indicators are the key factors that reflect the physical state and training effect of athletes. With the help of advanced sensor technology, AI can achieve real-time and accurate monitoring of multiple physiological indicators of athletes. In addition to the common and basic heart rate monitoring, the AI system can track a range of important indicators such as blood pressure, oxygen saturation, electrical muscle activity, and neuromuscular control in real time. Changes in blood pressure can reflect the circulatory load of athletes during training, oxygen saturation can reflect athletes' respiratory function and oxygen supply capacity, and muscle electrical activity and neuromuscular control indicators are essential for in-depth analysis of athletes' sports performance and muscle function. [4] Taking the training of sprinters as an example, the attachment of electromyography sensors on the surface of leg muscles is an important means of AI monitoring. Through these sensors, the AI system can carefully analyze the contraction force and explosive force of the muscles, as well as the neuromuscular coordination. At the start of a sprint, every subtle movement and muscle force affects the starting speed and acceleration ability. When the AI system detects that the athlete's muscle activation sequence during the starting phase is abnormal, or the power output is unbalanced, it will quickly capture this information and alert the coach and athlete in time. Based on this feedback, coaches can adjust their training plans in a targeted manner to help athletes optimize their starting technique. Athletes themselves can also be more aware of their own physical condition and consciously correct wrong movements in subsequent training, so as to improve their starting speed and acceleration ability, and lay the foundation for better results. This AI-based physiological indicator monitoring provides a scientific and accurate basis for track and field physical training, making the training more efficient and targeted. [5]

(2) Monitoring and correction of technical actions

In track and field physical training, the standardization of technical movements is directly related to the improvement of athletes' performance and sports safety. With computer vision technology and deep learning algorithms, AI provides strong support for the monitoring and analysis of track and field athletes' technical movements, and achieves high-precision monitoring results. Especially in long jump, high jump and other events that require high technical movements, the application advantages of AI systems are particularly significant. First of all, multiple high-speed cameras will be carefully set up around the training venue, which can capture the details of the athletes' movements in all aspects such as running, jumping, taking off, and landing. Every subtle movement change can be clearly recorded, providing a rich data basis for subsequent analysis. [6] Secondly, the AI system has a built-in excellent athlete action model library trained and accumulated by a large number of professional athlete data, and the AI compares and analyzes the captured athlete action data with the model library, which can quickly and accurately identify the deviations and deficiencies in the athletes' technical movements. Taking the running rhythm of a long jumper as an example, the stability of the running rhythm and the inverted technique of the last few steps play a decisive role in the long jump performance. The AI system can accurately calculate the change in the length and cadence of each step of the athlete, as well as the change in the body's center of gravity. Through these precise data, the AI can keenly detect whether the running rhythm is stable and whether there is any fast and slow situation; At the same time, it can also judge whether the inverted board technique of the last few steps is standardized, and whether there are problems such as premature leaning forward and chaotic steps. Once a problem is identified, the AI will give timely feedback to show the athlete and coach the exact location and extent of the deviation in an intuitive way. At the same time, the AI will also provide targeted improvement suggestions, such as

adjusting the speed of the run-up and changing the pace of the pace. Athletes can follow these suggestions to train and adjust in a targeted manner, and gradually standardize their technical movements, so as to improve their sports performance and achieve better performance on the field. [7]

3. Evaluation of the effect of AI-empowered athletics physical training

(1) Comprehensive assessment of multi-dimensional data

Traditional track and field performance is mainly evaluated based on the timing performance of running events, distance or altitude changes in jumping events, etc., although the training effect can be measured, but it can only reflect the competitive performance of athletes at a specific moment, and cannot deeply reveal the impact of training on athletes' physical function and technical ability. AI, on the other hand, expands the scope of evaluation to multiple dimensions such as physiological index data and technical action data, integrating multiple data before and after athletes' training for a comprehensive and accurate comprehensive evaluation. This evaluation method breaks the limitations of relying only on a single performance index in the tradition, and provides a more scientific and comprehensive basis for the judgment of athletes' training effect. For example, AI will not only compare the athletes' performance before and after training, but also analyze a series of physiological indicators of the athletes. [8] For example, VO2 max is an important indicator of an athlete's aerobic endurance, and AI can determine whether the aerobic metabolism of an athlete has been improved by analyzing the RO2 data of an athlete before and after training. The lactate threshold reflects the critical point at which an athlete begins to accumulate a large amount of lactate during exercise, and AI is able to monitor whether the lactate threshold has increased to assess whether the athlete's ability to resist fatigue has increased. In addition, the AI analyzes the running economy and determines whether the energy efficiency of the athlete is improved by studying the energy consumption data of the athlete while running. At the same time, the AI will also evaluate whether the standardization and stability of the athlete's technical movements are enhanced, such as whether the cadence, stride length, and body posture during running are more reasonable. Therefore, through the comprehensive evaluation of multi-dimensional data, the training effect of athletes can be judged more comprehensively and accurately, which avoids the one-sidedness that may be brought about by relying solely on performance evaluation, and provides strong support for coaches to formulate follow-up training plans. [9]

(2) Predict future training potential and performance trends

In track and field physical training, AI can also provide a scientific basis for athletes' future training potential and performance trend prediction with its powerful data analysis and modeling capabilities. First, AI is able to perform in-depth analysis of athletes' long-term accumulated training data. First, from the perspective of physical fitness indicators, AI will carefully observe the improvement trend of various indicators such as strength, speed, endurance, and flexibility. For example, whether the athlete's bench press strength has increased steadily over a period of time, whether the speed of the 100-meter sprint has gradually accelerated, and whether the endurance of long-distance running has been significantly improved. Second, in terms of improving technical movements, AI will analyze the standardization, coordination, and stability of athletes' movements, such as whether the starting posture is standard, whether the hurdle technique is smooth, and whether the throwing action is in the correct sequence. Third, in terms of adaptability to training load, AI can evaluate the body's reaction and recovery under different training intensities and frequencies to determine whether they can withstand higher intensity training. Based on the comprehensive analysis of this data, AI can use advanced predictive models to estimate the level of performance that athletes are likely to achieve in the coming period with different training scenarios.

This prediction provides a valuable reference for the coaching team. Based on the prediction results, the coaching team can formulate a reasonable participation plan in advance, and reasonably arrange the frequency and event selection of athletes in different events. At the same time, it is also possible to formulate a long-term training plan and clarify the training goals and priorities at different stages. [10]

4. Conclusion

From the above, it can be seen that AI technology has great potential and obvious advantages in the precise training and intelligent monitoring of track and field physical fitness, which can provide more scientific, accurate and personalized solutions for the training of track and field athletes, and promote the development of track and field training to a better level. In the future, with the continuous progress of AI technology, the reduction of costs, the continuous improvement of the data security system, and the improvement of the interdisciplinary talent training and cooperation mechanism, AI-empowered track and field physical training will inject new impetus into the training of track and field athletes, the improvement of the competitive level and the scientific development of sports, and also provide useful reference for the training innovation of other sports.

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