

Research on inverse simulation of physical training process

Zhao Xin¹, Longg Xingnian¹, Changkui Chen^{2,*}

¹Wuhan Sports University, Wuhan 430079, China

²Party School of the ShanDong Committee of the CPC (Shandong Administrative College), Jinan 250000, China

Keywords: physical training; control; inversion integral; fuzzy; human attitude parameter adjustment

Abstract: In order to improve the control ability of the human body in the process of physical training, it is necessary to carry out the inverse simulation analysis of the physical training process and establish the process control model of the physical training. A physical training process control model based on inverse integral and fuzzy control is proposed. The complex problem of high-dimensional spatial motion planning involved in physical training is decomposed into a series of sub-problems in low-dimensional space, and the inertial attitude parameter fusion is carried out according to the position and pose state of the human body in the end of the workspace during the process of physical training. The multi-dimensional control of physical training process is carried out by fuzzy constraint and inverse integral control, and the attitude parameters of human body are adjusted by means of mechanical analysis model and inertia parameter analysis method. The inversion simulation control is realized in the process of physical training, and the effect of physical training is improved. The simulation results show that the inversion simulation control has better convergence, higher control quality and better inverse simulation performance in the process of physical training, which can effectively guide physical training and improve the effect of physical training.

1. Introduction

With the rapid development of science and technology, people pay more and more attention to improving the quality of physical training by means of science and technology. In the past sports training process, the trainer used the less difficult video replay and the analysis management way to explain the movement key points for the athlete is not intuitive and scientific, lacks the authenticity and the interaction. It cannot meet the basic evaluation requirements of athletes' movement norms and training results. However, the sports video can extract the training parameters of athletes, and can further analyze the training parameters by constructing models and observing the training movements, so as to obtain the results of the analysis of the pros and cons of the athletes' training actions^[1]. Ensure athletes know their shortcomings intuitively and improve the quality of physical training according to the guidance of coaches. The movement of human body is a fuzzy control process in physical training. By simulating the posture of human body in physical training and combining with the method of mechanical analysis, the motion model of human body can be analyzed and the effect of physical training can be improved. It has important application value to study the simulation method of human body posture in physical training^[2].

Traditionally, the research of human body attitude simulation control algorithm in sports training is mainly divided into path offset correction and path tracking control algorithm based on particle filter motion rigid trajectory decomposition and motion attitude simulation control algorithm based on genetic evolution algorithm^[3]. In physical training based on genetic algorithm, the human body control algorithm is commonly used. In reference [4], a reinforcement learning algorithm based on neural network is proposed and applied to human trajectory correction and tracking control in physical training. And in the physical training of the human body to avoid obstacles in good practice, based on neural network reinforcement learning algorithm, combined with intelligent

control structure applied in mobile sports training of human path and motion posture simulation control. The algorithm takes the human body in physical training as the model, which has certain guiding significance, but the model is not detailed enough, and cannot completely reflect the characteristics of human body positioning and sports posture simulation in sports training, and the tracking control performance is not good. In reference [5], an algorithm of simultaneous location of human body and map creation in sports training based on particle filter was proposed, and the pose model of human body and the creation of map of surrounding environment in sports training were obtained. The attitude tracking control of human body in physical training is realized, but the calculation accuracy of the algorithm is not high, and the realization is more complex, and the application value is not good^[6]. On the basis of designing human posture integral synovium control in physical training, multi-tree hybrid genetic evolution method was used to track human pose target in physical training, and human body trajectory control was carried out under multi-information fusion. The control accuracy is improved, but the convergence performance of the algorithm is not good, the local optimization ability and search speed need to be improved[7]. It is concluded that human posture is a multivariable nonlinear control system affected by small disturbance piecewise linear error in physical training. The traditional genetic algorithm for motion attitude simulation control appears steady tracking error in the boundary layer.

In view of the above problems, this paper presents a physical training process control model based on inverse integral and fuzzy control. The complex problem of high-dimensional spatial motion planning involved in physical training is decomposed into a series of sub-problems in low-dimensional space, and the inertial attitude parameter fusion is carried out according to the position and pose state of the human body in the end of the workspace during the process of physical training. The multi-dimensional control of physical training process is carried out by fuzzy constraint and inverse integral control, and the attitude parameters of human body are adjusted by means of mechanical analysis model and inertia parameter analysis method. The inversion simulation control is realized in the process of physical training, and the effect of physical training is improved. Finally, the performance test is carried out through the simulation experiment, which shows the superior performance of improving the sports posture simulation and control under the method of this paper.

2. Design of body posture environment model and analysis of constraint parameters in physical training

2.1. Human posture simulation model for physical training

In this paper, we first simulate and construct the human posture simulation model in sports training, using bottom-up Agent modeling method, Abstract the human posture spatial coordinate into the virtual world of genetic population^[8]. The human posture distributed structure model of physical training is shown in figure 1.



Figure 1. Distributed structure model of human posture in physical training

In physical training, the movement space of human body can be expressed by a plane right angle coordinate system, which is organically connected with macro and micro. The optimization of human body's path and the control of posture simulation in physical training are generally based on the multi-information fusion model of N decision variables.

2.2. Description of Human body posture simulation control parameters in physical training

On the basis of constructing the grid structure model of human body motion space in physical training, this paper analyzes the environment parameter model of human body posture simulation control in sports training, and according to the classical genetic algorithm, In the process of sports posture simulation, the human body finds the target point and moves through the way of genetic evolution. The sensor collects a certain amount of external data, and it carries on the information characteristic analysis and the control.

By describing the parameters of human posture simulation control in sports training, this paper provides a data basis for human posture simulation control in sports training.

3. Algorithm improvement design and implementation

According to the above analysis, it can be seen that the posture of human body is affected by the small disturbance piecewise linear error in sports training, and the human body attitude control system is a multivariable nonlinear control system in sports training. The traditional genetic algorithm (GA) is used to simulate the motion and attitude control and the steady tracking error occurs in the boundary layer. In view of the disadvantages and defects of the traditional methods, this paper presents an improved genetic algorithm based on the human body posture simulation control algorithm in sports training.

4. Simulation experiment and result analysis

In order to verify the application performance of this method in the process control of physical training, the simulation experiment is carried out, the model of human attitude parameter acquisition and characteristic analysis is constructed, and the signal acquisition sensor is designed. Three data are obtained for each sensor. The simulation scene of human body motion space in physical training is in a 2D plane of 300. The starting point of human attitude distribution coordinate is [20,20], [250,250]. We adopt the international standard data set opportunity Activity recognition data set, which includes a large number of acceleration and RFID tags data, a total of 250 attributes.

5. Conclusions

In this paper, a physical training process control model based on inverse integral and fuzzy control is proposed. The complex problem of high-dimensional spatial motion planning involved in physical training is decomposed into a series of sub-problems in low-dimensional space, and the inertial attitude parameter fusion is carried out according to the position and pose state of the human body in the end of the workspace during the process of physical training. The multi-dimensional control of physical training process is carried out by fuzzy constraint and inverse integral control, and the attitude parameters of human body are adjusted by means of mechanical analysis model and inertia parameter analysis method. The inversion simulation control is realized in the process of physical training, and the effect of physical training is improved. The simulation results show that the inversion simulation control has better convergence, higher control quality and better inverse simulation performance in the process of physical training, which can effectively guide physical training and improve the effect of physical training. This model has good application value in process control and posture simulation of sports training.

References

- [1] MA Yu CAI Yuan-li, (2016). Scheduled offline model predictive control based on multiple LPV models. *Control and Decision*, 31(08), pp. 1468-1474.
- [2] Wan Z, Kothare M V, (2004). Efficient scheduled stabilizing output feedback model predictive

- control for constrained nonlinear system. *IEEE Trans on Automatic Control*, 49(7), pp. 1172-1177.
- [3] Li K Y, (2013). PID Tuning for Optimal Closed-Loop Performance With Specified Gain and Phase Margins *IEEE Transactions on Control Systems Technology*, 21(3), pp.1024-1030.
- [4] Wang Y G, Shao H H, (2000). PID Auto-Tuner Based on Sensitivity Specification. *Chemical Engineering Research and Design*, 78(2), pp. 312-316.