



Intelligent Analysis Method of Sports Training Posture Based on Artificial Intelligence

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Abstract. Before the rise of high technology, people rely on the naked eye to observe sports training skills, but with the development of AI technology, various high-definition camera capture machines have been developed that can record the movements of athletes, so that athletes can learn from the video. The shortcomings of the training methods (TM) are found in the images. This method can analyze and compare the athletes' postures by scientifically quantitatively analyzing the sports characteristics of the athletes. Combined with the principles of human physiology, it proposes methods to improve the sports movements to assist the athletes' training, so as to remove the traditional sports (TS). The training is purely based on experience. The sports training auxiliary analysis system constructed in this paper helps trainees adjust their training postures and movements, realize intuitive sports analysis and instruct, and enhance the level and grades of athletes.

Keywords: Artificial Intelligence · Sports Training · Posture Actions · Motion Features

1 Introduction

Nowadays, people use AI technology to build a sports-assisted training platform to provide athletes with a scientific and reasonable training mode. This paper establishes a set of sports posture intelligent analysis system, and applies the research content to sports training to accurately analyze the training posture of athletes, so as to improve the athletic level of athletes.

There have been many related researches on artificial intelligence-based sports training posture intelligent analysis methods at home and abroad, and have shown fruitful research results. For example, foreign companies take billiards training as the research object, use two monocular cameras to capture the players' swing motions, collect the players' swing image information and keep them as video files, and then analyze the players' swing motions in the training videos, and analyze the players' swing motions in the training videos. This analysis process is compared with the action process in the standard operation library, so as to provide guidance and suggestions for hitting the ball, so that the standard of athlete attitude evaluation is more comprehensive [1]. The auxiliary training system developed by a scholar manually labels data for each joint point(JP) of

the human body(HB) during the trainer's swing, so that some important physical parameters of the trainer's movement process can be obtained through calculation, and then the trainer is captured by laser measurement and tracking. Position or speed and other parameters in the process of exercise, and then ask professional coaches to evaluate these parameter data, put forward reasonable training suggestions to trainers, and achieve the purpose of digital teaching [2]. Although the research results on the intelligent analysis method of sports training posture are good, so as to improve the exercise skills of the trainer, we need design an auxiliary training system combined with AI technology to help the trainer correct the wrong training posture.

This paper firstly introduces Kinect as a sensor used to obtain joint data of people when they are exercising, and proposes a pose estimation method for sports training. Then use AI technology to design auxiliary training system, use Canny edge detection algorithm and Kinect sensor to obtain trainer's motion posture data, and finally compare the posture conformity of trainer and coach to help trainer correct training posture and realize standardized training.

2 Human Pose Estimation Analysis Method

2.1 Kinect Sensor

Kinect is actually a depth camera that can obtain depth images and color images at the same time, and it can obtain depth images that capture poses through optical encoding technology. Kinect can seize 30 frames of data, and color image data can be obtained by transferring mathematical functions [3]. When the Kinect sensor captures joint data, Kinect uses its bone recognition and tracking technology to first separate the foreground and background of the depth image, and then identify the key JP of the bone through the bone joint classifier based on depth features, and continue to track these joint points [4, 5].

The separation of the foreground and the background of Kinect adopts the separation strategy to separate the human body from the complex depth image, uses the image segmentation method to remove the background image, and only outputs the human body image, which reduces the calculation amount of the subsequent processing process [6]. The researchers developed an AI project model system for Kinect to identify various parts in the HB. After the training of the data, the decision tree classification can screen out the main JP of the HB and continuously track the skeleton points. Tracking multiple sets of skeleton points, that is, to achieve skeleton tracking for multiple people, combined with depth measurement data, establish a spatial 3D coordinate system with the infrared camera as the origin, and return the 3D coordinates of each joint point in real time [7, 8].

2.2 Attitude Estimation Method for Sports Training

(1) Model-based (MB) Human Pose Estimation (HPE)

The MB HPE method plays a key role in the pose estimation and tracking process. This method is to first establish a joint tree or other model for the HB, and obtain the

HB model by establishing the control relationship between the HB model and the HB features in the image parameters, and finally achieve the purpose of HPE, which belongs to a top-down method [9].

The model-based HPE method is related to the prior knowledge of the HB model and training motions, that is, the model shape (MS) at a certain moment depends on MS at the previous moment. By mapping the HB and the characteristics of the HB in the image between them is used to find the best fit method to obtain the HB stance parameters. The procedure employed the model-based HPE method is generally “prediction, accordance and renew”, firstly, establish a HB model, and then Then, according to the dynamic model, the pose of the HB in the current frame is assumed to be the results of the previous frame of human pose estimation, and the assumed result is corrected by the posture evaluation function [10].

(2) Model-free HPE

Under the premise that there is no model of HB posture, in order to evaluate the HB posture, the parallel relationship between the edge, color, contour and other features of the HB in the image observation space and the HB posture in the projection space can be transformed into a gesture action recognition problem. This model-free approach can also be called a bottom-up approach [11]. There are two forms of model-free pose estimation. One is the method based on learning, which needs to use many training samples (TS) to test the LR model. Based on the learning of large data samples, the HB posture images are trained for many times to obtain posture features. The small storage cost ensures the fast execution efficiency of the method. The second is the matching-based method, which extracts the corresponding features in the image, finds the learning sample of the class test when inputting the test image, and then uses the nearest reference object to evaluate the human pose in the image. The execution process of the method firstly completes the description of the HB contour features to form the HB contour features with feature vectors, and then compares with the sample set containing the human body contour features, and selects the samples with the most similar features as the result of pose estimation. In this method, due to the need for a large number of training samples, the operation difficulty coefficient is large, resulting in a large deviation of the estimated results, which cannot solve the problem well.

The disadvantage of the model-free pose estimation method is that the algorithm is relatively complex, the time spending of modeling and the work cost of TS are high, and the estimation accuracy is easily restricted by the size of the training samples long time. And due to the diversity of human poses, the correspondence between the feature descriptors of the human body and the pose space is not one-to-one. In most cases, many different poses are projected to correspond to very similar image features [12].

(3) HPE based on contour edge(CE) features combined with image processing (IP)

The model-free HPE method based on matching is affected by sample set, and is highly dependent on the selection of image features, and the accuracy is not too high. Therefore, a HPE algorithm based on CE combined with IP is proposed. Through this algorithm,

the JP of the HB in the picture can be automatically marked, and its pose coordinate points can be obtained.

2.3 Human Silhouette Edge Feature Extraction

The Canny edge detection algorithm obtain the CE of the HB posture image, and then the coordinates of the HB JP are obtained by the image processing method, so as to detect the standardness of the posture. The Canny edge detection algorithm (EDA) performs Gaussian filtering on the image, which can effectively suppress noise and achieve the purpose of denoising.

$$W = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{x^2}{2\sigma^2}} \tag{1}$$

$$W' = \frac{1}{\sqrt{2\pi}\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}} \tag{2}$$

Among them, W is a one-dimensional sum vector, W' is a two-dimensional kernel vector, σ is a parameter, and x and y are the abscissa and ordinate of the joint point, respectively.

3 Design of Sports Training Posture Assistant Analysis System Based on AI

3.1 System Function Design

The function of the system takes the wave image formation of the trainer and coach (TAC) as the input, and uses the change of the posture suitability of each photo of the trainer and the coach as the output of the AST index. According to the posture similarity, the trainer’s movements are corrected to analyze the movement posture and provide training suggestions, and realize the transformation from the TS TM to the computer vision-based HB analysis method.

3.2 System Module Composition

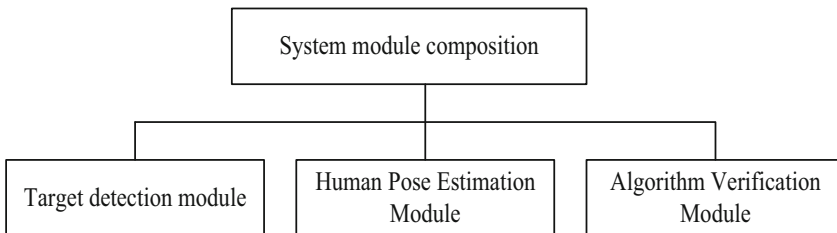


Fig. 1. System modules

Figure 1 shows the three major modules of the auxiliary training analysis system.

(1) Target detection module

Effectively abstracting HB or features is an indispensable measure in pose reckon and is the element step of the ASTS. The object detection module randomly selects human pose image samples. When the image pixels cannot be determined, the pixel update mode can also ensure the sharpness of the image pixels.

(2) Human pose estimation (HPE) module

HPE is a part in the ASTS. By obtaining posture from video or image sequences, analyze action patterns, and posture auxiliary indicators are established. In this paper, a HPE method based on CE features connected with IP technology is used to further process the features draught by target discover. First, the Canny EDA is used to obtain its CE, and then the horizontal scanning, human length ratio constraints, etc. The image processing method obtains the coordinates of the JP of the HB.

(3) Algorithm verification module

The algorithm verification module is to verify the accuracy of the ASTS. This part uses the attitude data collected by Kinect as the standard database to verify the accuracy of the algorithm.

4 System Application

4.1 Algorithm Accuracy Verification

The Canny EDA is used to get the edge of the HB figure, and then the location of the JP of the HB are obtained through IP methods, so as to achieve the purpose of HPE, and compare it with the posture data collected by the Kinect sensor. And analysis to complete the accuracy verification of the algorithm.

Table 1 shows the coordinates of the trainer's head, neck, shoulder, elbow, wrist, crotch, knee, ankle and other joint points extracted by the contour plus image processing method and the Kinect extraction method. The average value of the relative error is 3.51%, indicating that the Canny edge detection algorithm in this paper combined with the Kinect sensor to process image pose estimation is more accurate.

4.2 Analysis of System Application Results

The training videos of trainers and coaches are collected separately. The exercise videos of trainers are obtained by Kinect, and the training videos of coaches are obtained from online teaching videos. 10 sheets of training images (TI) of the TAC are selected as the input of the ASTS, and the output is the fit of the training posture of each frame of the trainer and the example posture of the coach. Figure 2 shows the fit of the three trainers compared to the coach's example poses as a function of frame number, as shown by the ASTS.

Table 1. Comparison of joint extraction results

	Contour plus image processing method	Kinect extraction	Relative error (%)
head	(20,36)	(22,38)	2.47
neck	(20,32)	(21,27)	3.10
shoulder	(21,28)	(22,29)	3.26
elbow	(24,25)	(24,26)	4.53
wrist	(18,22)	(19,23)	3.36
crotch	(27,23)	(28,25)	3.18
knee	(36,15)	(37,17)	3.94
ankle	(34,23)	(26,25)	4.21

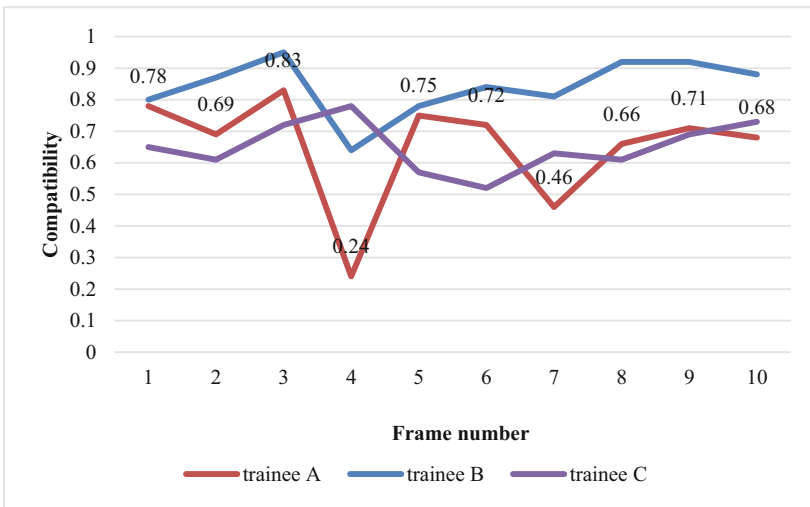


Fig. 2. The fit of the training posture of trainees and coaches

According to the fit test results in Fig. 2, it can be seen that among the 10 frames of images, trainee B has the highest degree of fit with the coach’s posture and actions, followed by trainee C, and trainee A’s posture fit fluctuates greatly, which means that trainee B has the highest degree of fit. The most standard gestures. During physical training, trainees can standardize their posture and movements by comparing them with the coach’s training posture, so that the training effect can be improved by achieving a degree similar to the standard movements.

5 Conclusion

Traditional ASTS often relies on experience by hand and cannot give accurate data analysis of crucial action. This paper builds an ASTS based on the method of HPE, and uses AI technology to optimize the function of the system. In the application test of the system, the TI of the TAC are used as the input, and the posture fit of the TAC is used as the output of the auxiliary training index. Sports training brings standardized analysis and quantitative guidance.

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