Design of Online Auxiliary System for Action Teaching Based on Reinforcement

Xueqin Wu(✉)

Wuhan Institute of Physical Education, Martial Arts School, Wuhan 430079, Hubei, China
wuxueqin202101@163.com

Abstract. Through the combination of artificial intelligence technology and distributed technology, this paper puts forward a design scheme of Taijiquan action teaching online assistant system based on deep learning, which can be applied to Taijiquan teaching, broadcast gymnastics, fitness action and other fields, and provide intelligent action coach for users in the environment of no guidance. The platform adopts the front-end and back-end separation development, and uses the distributed and cluster technology to solve the problems of high concurrency and availability. Through tensorflow.js framework, the platform can identify, analyze and guide actions in real time on the front end, which can avoid privacy leakage and server overload in the front and back end data interaction. Through the scoring and comparison algorithm, users can constantly correct their actions in the process of using, and achieve the positive feedback effect of action learning.

Keywords: Action identification · Action teaching · Deep learning · Taiji boxing

1 Introduction

With the promotion of Internet plus, the combination of Internet technology and other industries is an inevitable trend in modern society. In this context, building an intelligent fitness service platform combined with Internet technology has important strategic significance for promoting the equalization of public sports services and building a modern, scientific and intelligent national fitness service system.

Due to the sharp rise in the number of students and the increasing complexity of teaching courses, the task of teaching management in Colleges and universities is becoming more and more important. Once the teaching managers make mistakes, they often waste teaching resources and even lead to serious teaching accidents. The construction of digital campus makes various network applications have a platform and rely on. Considering that now all colleges and universities have basically established a complete campus network, we can rely on the existing campus network to design a web-based online teaching management system, which can reduce the work pressure of teaching management departments and prevent mistakes in teaching management.

The existing fitness platform products have reliable video teaching courses. Users can learn professional sports knowledge, but lack of feedback in the learning process, users can not understand the gap between their own actions and standard actions. The

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new platform combined with AR/VR technology has high cost, great technical difficulty and high hardware requirements, which is difficult to achieve, and it is also difficult to achieve the effect of equalization of public sports services. In order to promote the innovation of fitness service platform, we need lower but more effective technical means to build it. This paper consists of the following parts. The first part introduces the relevant background and significance of this paper, the second part is the related work of this paper, and the third part is data analysis. The fourth part is example analysis. The fifth part is conclusion.

2 Related Work

Reference [1] proposed a mobile learning model from the perspective of distributed cognition. In comparison with common teaching auxiliary system, Jing designed an online English course teaching system [2]. The objective of Ref. [3] were 81 English lecturers of some colleges or universities in Indonesia. Mishra et al. seek to address the required essentialities of online teaching-learning in education amid the COVID-19 pandemic and how can existing resources of educational institutions effectively transform formal education into online education with the help of virtual classes and other pivotal online tools in this continually shifting educational landscape [4]. Sun et al. developed an online English teaching system in comparison with the common teaching auxiliary system [5]. And Miao proposed an English hybrid intelligent teaching assistant model based on mobile information system development, which integrates massive English teaching resources [6]. In view of the poor communication quality and flexibility of current streaming media technology, Wang built a selective streaming media online teaching architecture based on animation media service platform [7]. The system adopts three-tier architecture, pays attention to good scalability, adopts modular design method, divides it into four functional modules: teaching resources, online Q & [8]. Experimental data show that the stability of the design method is better than the other two traditional methods [9]. The platform adopts SSM framework based on Spring architecture as the cornerstone and is oriented to ordinary users and teachers and students Ref. [10].

The existing fitness platform product is the existing fitness platform (non product) concept, which mainly includes a new intelligent fitness platform based on physical perception technology, augmented reality and virtual reality.

2.1 Rationality of the Teaching Method of Taijiquan Movement Decomposition

1) The complicated Taijiquan style is divided into several movements to teach. Beginners are easier to understand, imitate and remember, so they can learn and practice well in a short time.
2) Through such practice, not only can the complete posture (fixed form) of each type be grasped perfectly, but also the transition movement can make the route and the arrived position of trunk and limbs correct according to the requirements.
3) During the practice of decomposition teaching, each action can be stopped in that position, and checked and corrected by teachers or students at any time.

Some people, after learning Taijiquan, insist on practicing, but some boxing styles will still be "out of shape", which is not in accordance with the standard, which also needs to be reviewed and corrected by the method of action decomposition. So the practice of decomposition method is not only suitable for beginners, but also necessary for the improvement of practitioners.

When teaching with the method of action decomposition, I insist on making students grasp one posture correctly before learning the next action. I don't advocate that kind of method that ignores quality and learns to "draw a path" first and then correct it. At the same time, each class uses the time of the fake preparation to arrange some basic movements such as step type, footwork, body method and technique, which will help to improve the teaching quality.

Some people worry that teaching Taijiquan with decomposition action will be practiced as "doing gymnastics" and lose the style of Taijiquan "continuous". In fact, this concern is unnecessary. When teaching new movements, we should use the method of action decomposition. When teaching the formula after teaching, we should review the formula learned before repeatedly and continuously, and gradually increase the content of explanation so that students can understand and master the characteristics and requirements of Taijiquan (equivalent to the "detailed explanation of the movement essentials" of the twenty-four types). With the improvement of proficiency, the decomposition movement can be gradually connected to meet the requirements of Taijiquan, such as round life, coherence, coordination and even speed. For example, the action decomposition is like a crutch. When you can walk, you can throw it away.

2.2 The Development of Deep Learning

In other words, deep learning is machine learning based on artificial neural network, which is often called AI (Artificial Intelligence). Its core idea is to use fewer network parameters, deeper network depth and more complex network model to complete the corresponding tasks, and use a large number of samples to replace more parameters used in traditional machine learning, Reduce a large number of manual labels in the sample to complete its target task. In short, it is to replace the high-cost manual labels with high-quality training data by increasing the number of data. Although deep learning is derived from machine learning, it is actually a solution, but it is very different from traditional machine learning algorithms. The inspiration of deep learning comes from neurons in human brain, and its core is data processing through computing units such as neurons as basic units, The idea of combining a large number of neurons to form a neural network to solve more complex problems can be traced back to an MP model proposed in a paper published by psychologist McCulloch and mathematician Pitts in 1943. This is the earliest working principle that imitates the physiological structure of the human brain in medical research and is introduced into mathematical scientific calculation, It can be seen from the figure that the following formula is obtained:

$$y_j = \sum_{i}^{n} w_{ij} - \theta_j \tag{1}$$

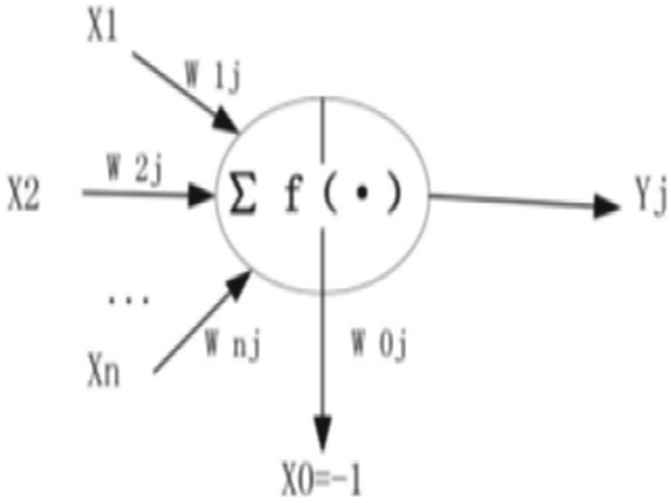

Fig. 1. MP network neuron

As shown in Fig. 1, the input data X is input into the neuron, calculated with the corresponding weight WJ, added with the set threshold, and finally summed to obtain the corresponding output value y. This is the simplest neural network model. The essence of deep learning is actually the process of constantly learning to calculate the weight and threshold of the neuron in the neural network, Only after training mature neurons to calculate can we get accurate output. After the introduction of the concept of neuron, its calculation process is a process that requires people to continuously participate in the operation. For different inputs, different weight parameters need to be manually adjusted to complete the corresponding output tasks. How to establish the relationship between operation unit neurons is an obstacle to the construction of neural network. Since the concept of bionic neuron is adopted, Therefore, we can learn the connection between neurons to find a solution. In 1949, Canadian psychologists proposed a rule Heb theory based on unsupervised learning. This theory is defined as follows. People can assume that continuous and repeated reflex activities will lead to a lasting improvement in the stability of neurons, When the axons of two neurons are very close and generate continuous stimulation, some growth processes or metabolic changes will occur in the two neurons or one or both of them, resulting in enhanced efficiency between the two cells. Therefore, MP network based on Heb theory lays the basic model of neural network.

3 Data Analysis

3.1 Distributed Architecture

Distributed architecture is a low cost method to solve high concurrency problems, and it has good scalability. The distributed architecture will process the service of business logic and the database of data storage are constructed in the way of nodes, reducing the load of a single node, and improving the overall performance of the system. It is a popular

way to deploy services and databases by docker. Docker is container virtualization technology, similar to a lightweight virtual machine iw%. Docker can be used for the construction, migration and operation of distributed applications. It allows developers or operation and maintenance personnel to package applications and their dependencies into a standardized container to realize the application configuration and run everywhere. Docker virtualization is much less expensive than traditional virtual machines, and it is easy to increase or reduce the operation of node containers, so it can deploy services more effectively.

The use of artificial intelligence technology based on machine learning can effectively strengthen the feedback effect of Taijiquan movement teaching exercise fitness learning. Through the technique of action recognition and action guidance, the part of the function of artificial intelligence action coach can be realized instead of real person coach. For the problem of action recognition, the current mainstream real-time recognition analysis method is the attitude estimation algorithm based on convolutional neural network model. Attitude estimation I8 is a computer vision technology, which can detect the characters in images and videos, so as to determine the coordinate position of the key points in the image. Besides detecting the key point data of 2D image, attitude estimation algorithm can be used to detect 3D key data of characters from image video, and to recognize 3D actions and build 3D character model.

Based on the distributed architecture, this paper proposes a general action guidance technology based on the latest movement recognition technology, and proposes an online auxiliary system design scheme for Taijiquan movement teaching which can be realized, high concurrency and high availability.

3.2 Overall Architecture Design

The system adopts the design method of separation of front and rear ends. The front end adopts Ant Design Pro framework, which follows spa design style, and packages the functions of routing, menu, permissions, reverse proxy, asynchronous request, etc. The front-end system communicates with the back end through asynchronous request. According to the data results returned, the content of the page is updated in real time, and the user interaction experience is improved. The front end is started by NPM and deployed to a separate web server, decoupled from the back end. The front end uses webpack or nginx to agent, solve the cross domain request problem and interact with the back end. The back end adopts spring Webflux framework, which provides real restful httpapi to asynchronous process the requests from the front end. The spring session and spring security are used to manage user login information, security token, data cache, etc.

Mongodb is selected as the database system in the data storage part, and the spring mongodb real-tive framework is used to exchange data with the back end without blocking. All data processing in the architecture is asynchronous. The front end sends out asynchronous request, the back end responds and processes asynchronously. Finally, it performs asynchronous IO with the database. The whole process takes the form of non blocking. The specific overall structure is shown in Fig. 2.

In Fig. 1, the presentation layer is used as the front-end part of the system, and nginx is used as the HTTP server and deployed to the server cluster through NPM. The

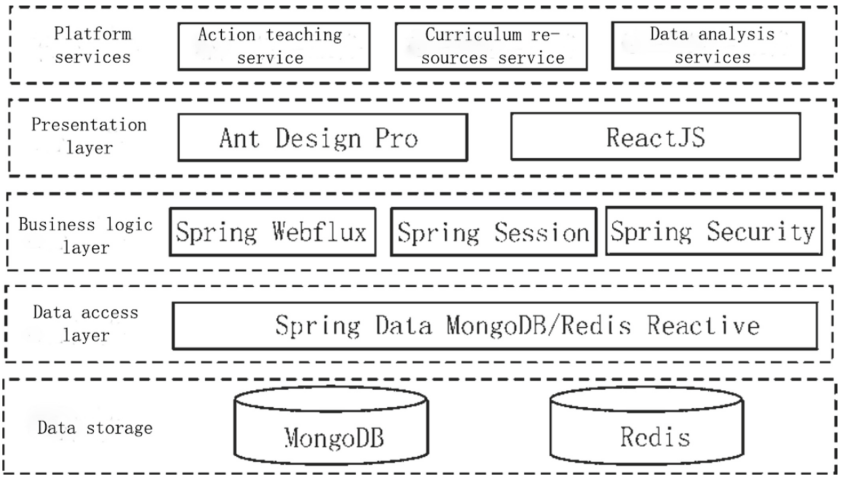

Fig. 2. Overall architecture design

back-end part of the system is composed of business logic layer and data access layer, which is deployed to the server cluster with the built-in netty of spring boot. Because the expected data reading load of the system is much larger than the expected data writing load, the data storage part of the system adopts the master-slave database cluster mode, which separates the database reading and writing and improves the data reading load capacity.

3.3 Action Teaching Algorithm

The action teaching service needs to realize the functions of action recognition, action evaluation, action guidance and so on. The action recognition function takes pictures, videos or live streams as input, performs bottom-up attitude estimation algorithm for input, obtains key point data, and then draws key points and action posture images in the source of transmission. If the input source is video stream, the input source is processed by frame, that is, the attitude estimation algorithm is performed once for each frame image.

After the action recognition, the similarity analysis algorithm is used to calculate the similarity cost of the two according to the key point data of the standard action and the user action, and the feedback results such as similarity evaluation score, standard action attitude projection image, user position offset direction and angle prompt information are calculated. The specific action teaching algorithm flow is as follows.

Firstly, the pose estimation of the characters in the standard action image is performed by posenet model, and the coordinate matrix of the key points of the standard action is obtained U_P and confidence matrix U_c. Where the coordinate vector of the K key is $U_{Pk} = (x_k, y_k)$, confidence degree is U_{ck}, K from 1 to 17.

$$U_{Pk} = U_{Pk} - U_{P0} \tag{2}$$

According to the standard action key point coordinate matrix U after linear transformation and normalization processing, the confidence matrix of the standard action key point U_P'', coordinate matrix of key points of user action V_P'', the cost of similarity is calculated as follows:

$$C = \frac{1}{\sum_{k=1}^{17} U_{ck}} \sum_{k=1}^{17} U_{ck} U_P'' - V_P'' \tag{3}$$

The standard action projection image is drawn on the user action image according to projection matrix w in real time by canvas, which provides reference for users to correct the action. Finally, according to the standard action projection coordinate matrix W and the UN normalized user action key point coordinate matrix V_P'', the vector difference and vector angle of the two parts are calculated to get the action offset prompt of each part.

Therefore, the final technical route of action teaching is shown in Fig. 3.

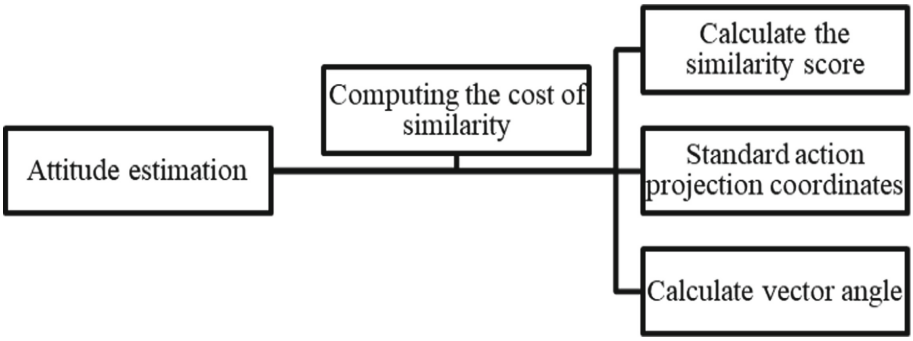

Fig. 3. Technical route of action teaching

4 Example Analysis

4.1 Quality Assurance in Each Stage of Software Project

According to the progress, software project development is divided into demand, design, implementation, testing and other stages. Quality assurance always runs through each stage, and corresponding measures must be taken according to the characteristics of each stage.

(1) System design and implementation stage

Implementation is the production process of code. This includes not only the generation of code, but also the generation of test cases. The detailed design is provided for the system design stage, the programmer starts coding and debugging the program, and the tester designs the test cases according to the product specifications. The designed use cases need to be approved by the project team members

and reviewed by the project manager before entering the configuration library. At the same time, after debugging the program, the programmer submits it to the tester for program correctness detection.

At this stage, we adopt the RUP unified process idea: support iteration and increment, allow changing requirements, allow continuous integration, reduce risks as soon as possible, improve reusability, and generate stronger products, so as to ensure the quality of products.

(2) System test phase

Strict and standardized software testing is undoubtedly of great benefit to the quality assurance of software products. Software test engineers should be involved in the project as soon as possible, and put forward some problems from the perspective of testing for the requirements and design of the project. The Development Engineer shall communicate with the test engineer on the problems existing in the product in time. The test engineer shall carefully read the product requirements documents and product specifications, and formulate a detailed test plan.

Common software testing strategies in online teaching system include:

Software correctness test: it mainly tests whether the functions of the software are correctly realized. The test method is mainly to see whether there is a given output according to the given input according to the functional requirements, and whether the output is abnormal in case of non-standard input.
Software performance index test: the performance requirements of the project are different from those of general software projects. Performance testing often includes stress testing, aggression testing and so on.
Software usability test: when designing and implementing the software interface, we should try to separate it from the realization of functions. The reason for the separation is that ease of use is achieved through a friendly interface.
Practice has proved that only by continuously implementing quality management measures in each stage of the project can we find problems as soon as possible and ensure the success of the project.

4.2 Data Analysis Algorithm

Statistics of the past learning of Taijiquan teaching courses by users, and the statistical charts and graphical sports reports are generated by using eckarts. The statistical charts such as learning duration are shown in Fig. 4. The sports report gives the numerical results of the number of courses, the length of study, the scores obtained by each course, the overall score, the trend of increase and decrease of the scores, the prediction of future scores, the ability values of each part of the body and so on.

Users can fill in comments or score for courses they have learned. The scoring of users will affect the intelligent recommendation of the system. The learning situation of users and the scores of each course are converted into points, and the ranking of points is given.

In addition, the system generates statistical charts and graphical motion reports based on the previous course learning of all users. The total number of courses, the total length

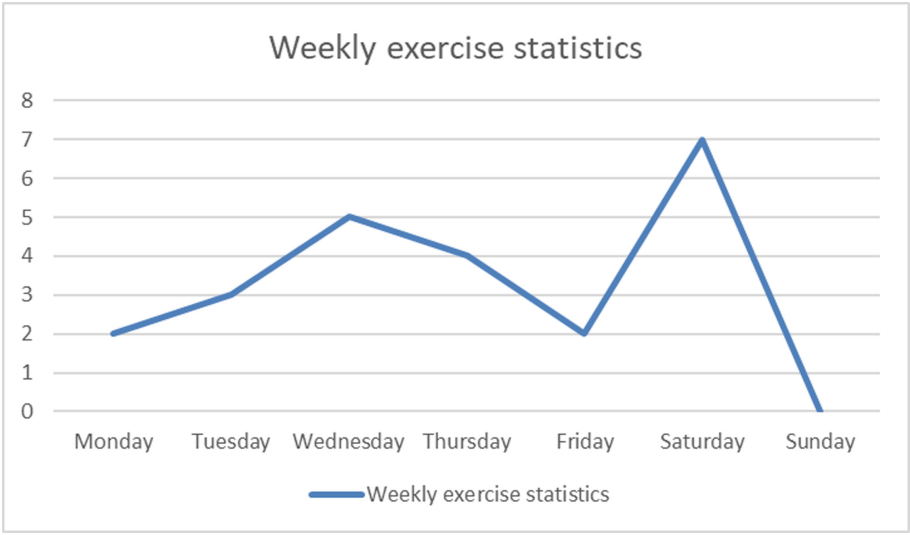

Fig. 4. Learning duration statistics

of study, the score of each course, the overall score, the average ability of each part of the body and other numerical results are given. It can analyze the user's course selection and learning, and get the user's characteristic portraits, such as the user's interest classification, the user's high click rate course category and other data.

Finally, the analysis of different user groups is realized, and the automatic division results of user groups are obtained by clustering algorithm, as well as the overall score increase and decrease trend and future score prediction obtained by statistics of all users.

5 Conclusion

Through the combination of artificial intelligence and distributed technology, this paper puts forward a design scheme of Taijiquan action teaching online assistant system based on deep learning. Its main purpose is to provide users with a large open online learning platform, including Taijiquan, martial arts, dance, gymnastics, sports and fitness. As an intelligent action teaching platform, intelligent technology is used to replace part of the functions of real action coach to a certain extent.

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