



# Design of Aerobics Network Teaching System Based on Artificial Intelligence

Rong Sun<sup>(✉)</sup> and Zhaoqi Fu

School of Physical Education, Jiangxi Science and Technology Normal University,  
Nanchang 330008, China  
sr202312@163.com

**Abstract.** The traditional network teaching system uses network video for aerobics teaching, which can not effectively correct students' movements. At the same time, its recommended resources are difficult to match students' learning ability, and can not provide targeted intensive training resources. In order to realize remote intelligent aerobics teaching and improve the teaching effect of aerobics course, an aerobics network teaching system based on artificial intelligence is designed. In the process of hardware design, the control module and peripheral function module are optimized. The software part uses the meanshif algorithm to track the students' bone information collected by Kinect, so as to correct the aerobics movement. At the same time, the neural network is used to improve the recommendation algorithm. According to the students' learning and action correction, aerobics teaching resources are recommended to meet the needs of students at different stages. The system performance test results show that after the application of the designed system, the action standard rate of students is increased to more than 90%, and the accuracy rate of Resource Recommendation is higher than 90%.

**Keywords:** Artificial intelligence · Aerobics · Network teaching · Teaching system · Meanshif algorithm

## 1 Introduction

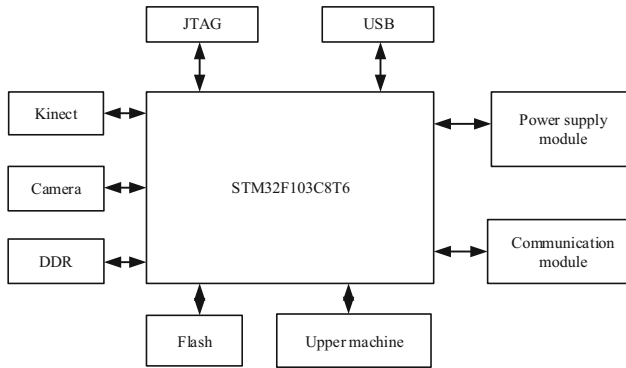
With the increasing maturity of Internet technology, computer technology and information technology, distance education and education system based on network have made great development and progress. Moreover, at this stage, multimedia technology has fully integrated network communication technology, and teaching work is carried out more in network conditions, which has completely changed the teaching mode [1]. Integrate information technology into the process of teaching and management mode innovation, promote development with innovation, and promote the reform of education service supply mode, teaching and management mode. In the process of development and progress of human society, it has been constantly studying the use of various machines to replace part of human labor, so as to reduce labor costs, improve work efficiency and improve productivity, which makes artificial intelligence come into being. The proposal

of educational modernization strategy not only creates conditions for intelligent teaching, but also promotes the development of intelligent teaching. Network teaching system is an important teaching auxiliary tool to promote the scientization of school teaching methods, teaching means and teaching modes, effectively apply various high-quality network education resources and advanced education technologies, improve the school operation mechanism and management form, and integrate the existing education and teaching resources. The network teaching system mainly uses the Internet to provide rich audio and video resources such as sound, animation and film for teaching. The traditional network teaching system has the problems of large data transmission delay and poor concurrency. The physical education teaching system exists more relying on the school teaching system, and the database capacity and system framework design that can be occupied are limited, which can not meet the needs of independently implementing its own design architecture according to the basic requirements and characteristics of physical education curriculum teaching. Therefore, the design of physical education teaching system is still in a more traditional and primary stage. Although the use of Android mobile teaching system improves the use of the client, it can not meet the needs of teaching when applied to Aerobics Teaching [2].

Bodybuilding is a fashionable sport, which originates from everyone's pursuit of health and beauty. With the improvement of China's education quality and the deepening of the education system, aerobics is introduced into the classroom of colleges and universities to shoulder the arduous task of strengthening the national physique and cultivating high-quality sports talents. Therefore, how to improve the quality of aerobics teaching has become the key to the optimization of aerobics teaching. At present, artificial intelligence technology has been applied to many fields of social production and life. However, in the field of culture and education, although schools at all levels have generally introduced many multimedia devices for network teaching, the application of artificial intelligence technology is still in its infancy [3]. With the mature development of artificial intelligence technology, it has great application potential in the field of culture and education, which is not only reflected in the teaching of knowledge with intelligent robots, but also can greatly help the design and application of school teaching system, making the school's educational administration and teaching system intelligent from the traditional network version, which is helpful to improve the school's educational administration management level, It is of positive significance to improve teaching efficiency. Therefore, according to the above analysis, this paper will use artificial intelligence technology to research and design aerobics network teaching system to provide more convenient, efficient and intelligent teaching auxiliary services.

## **2 Hardware Design of Aerobics Network Teaching System Based on Artificial Intelligence**

The design of the hardware part of the network teaching system mainly serves for the following artificial intelligence algorithm and network teaching research. Therefore, the hardware part of the system should meet the basic requirements of artificial intelligence technology. Figure 1 is the overall block diagram of the hardware part of Aerobics network teaching system.



**Fig. 1.** Hardware block diagram of Aerobics network teaching system

Real time acquisition of system communication signal and real-time data communication with PC. Combined with the needs of network teaching, the selected main control chip should not only have stable and reliable performance, but also have strong data processing ability and rich communication interfaces, but also have high-quality ADC module. Considering the system performance and cost, STM32F103C8T6 microprocessor is selected as the main control chip of the system. Use camera and Kinect equipment to realize human-computer interaction function and improve the effect of Aerobics network teaching.

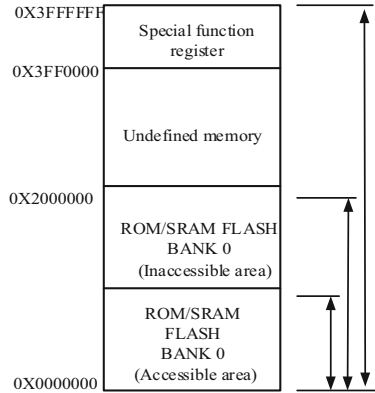
## 2.1 Control Module Design

STM32F103C8T6 is a 32-bit ARM microprocessor, which can choose to use internal or external clock. Through frequency doubling, the maximum frequency can reach 72 MHz; The chip contains 64 KB flash and 20 KB SRAM space; On chip 12 bit 10 channel ADC, the shortest conversion time is 1US, and the external bus controller with bus request/response pin can be used for real-time signal acquisition; Up to 9 communication interfaces, including 2 I2C interfaces and 3 USART interfaces, which can be used for data communication with identification module and PC; The power supply voltage is 2 V ~3.6 V, and there are three low-power modes: sleep, stop and standby, which ensure the requirements of low-power applications; Support JTAG interface to facilitate development and debugging [4].

The microprocessor supports large and small terminal modes. The internal architecture is big end mode, and the external memory can be big and small end modes. The access cycle of chip control programming can be set to 0 ~7 waiting cycles. The DMA transmit/receive buffer of the chip transmits and receives with 256 bytes.

When the system needs to be reset, the main control chip can be reset manually by pressing K1 key and automatically by power on. The following Fig. 2 is the schematic diagram of storage mapping when the main control chip is reset [5].

The quartz crystal with T1 of 32.768 kHz of microprocessor is used as a low-speed external clock, which is connected with pc14 and PC15 pins of STM32. It is generally used for RTC clock. When the power VDD is cut off, RTC can still work normally as



**Fig. 2.** Schematic diagram of reset storage mapping

long as VBAT supplies power; T2 is an 8 MHz quartz resonator as a high-speed external clock, with the OSC of STM32\_IN.OSC\_ The out pin is connected, and the frequency doubling output can be carried out through PLL phase-locked loop to provide 72 MHz working frequency for microprocessor core, or provide appropriate working frequency for on-chip low-speed equipment through frequency division.

### 2.2 Peripheral Function Module Design

In addition to the control module, the peripheral function module of Aerobics network teaching system hardware mainly includes communication module, power supply module, data synchronization module and surrounding circuits.

The communication interface of the camera uses video decoding chip ADV7183A. The chip is based on ITC – RBT 656 automatically detects pal composite video and decodes analog signals into digital video signals. The chip adopts a 4:2:2 sampling scheme, which can convert the signals of palsecam and NTSC into standard video signals compatible with itu 601 standard. It describes video digital signals using brightness and two color difference signals [6].

The video interface unifies the input data format and sends it to the image processing unit. When the data is on the 8-bit bus and the LLC1 clock signal arrives, it will remind the synchronizer that the data is valid. The output of this component is synchronous data and 6-bit signal bus. The signal bus contains a 4-bit status bus and a 2-bit content bus. The status bus is used to provide the position information of relevant pixels in the current frame. The 2-bit content bus indicates the Y, Cr or CB values of the current data. The input interface will process all pixel data from the video decoder, which will need to divide the effective video information into luminance component and chrominance component. To do this, the interface will need to start the valid video information (SAV) and end the valid video information (EAV) code to save the input track. These codes are 4-byte pixel sequences that separate valid and invalid pixels from each other. If the pixel data is not required, it can be discarded. The luminance component may be discarded because the existing algorithms only use two chroma [7]. After thresholding CB and Cr,

the input interface will respond to the request put forward by the control system and data storage in RAM. The video interface can be divided into two parts: input synchronization and state detection.

CP2102 chip is selected to bridge USB/RS-232. After installing the driver of CP2102 chip and initializing according to the data format defined by USB interface, on the one hand, the USB data transmitted by the upper computer can be converted into the format of RS232 information flow and sent to the main control module, on the other hand, the serial port data can be converted into USB data and transmitted to the upper computer.

Input synchronization is performed through a pair of triggers. This pair of flip flops reduces the possibility of metastable state entering the system by allocating a whole clock cycle between the two flip flops. A register loaded with asynchronous clock can synchronously output enough time signals for new valid data. The system clock here is set to 60 MHz. A fourth-order shift register stores the last four input data for the identification of timing reference marks. The LLC1 synchronization clock signal triggers the loading of the shift register. The contents of the shift register and the LLC1 synchronization clock signal provide input to the state generation component (ADC). Table 1 below shows the format of valid content input signal when the counter tracks data.

**Table 1.** Format setting of valid contents of counter

Data input	Most significant bit	Least significant bit
—	0	0
Y	1	1
Cb	0	1
Cr	1	0

When data exchange communication is carried out, it is output to the next stage except for status and content signals. The signal bus is only suitable for one clock cycle and is synchronized with the 8-bit output data bus. The signal bus format is always retained in the whole pipeline. Under the above hardware conditions, the software part of Aerobics network teaching system is designed by using artificial intelligence technology to realize the remote network teaching of aerobics course.

### 3 Design of Aerobics Network Teaching System Software Based on Artificial Intelligence

#### 3.1 Aerobics Movement Correction Design

In Aerobics network teaching, the system designed in this paper requires students to use Kinect sensor to realize human-computer interaction, so as to complete the correction and guidance of aerobics. Therefore, the algorithm is used to track Kinect bones, so

as to establish learners' human motion trajectory, and then carry out aerobics action correction.

In the depth image collected by Kinect, the upper 13 bits of the color information of a single pixel are the depth information, and the lower 3 bits are the user index (ID). 0 ~2 bits store the user index value, and 3 ~15 bits store the pixel depth value. Move the pixel data right by 3 bits to obtain the pixel depth value ( $\text{realdepth} = (\text{bufferrun}[j] \& 0xffff8) > > 3$ ). Table 3.1 shows the depth bits and index bits of the depth of field data, There are 13 depth bits (D3~D15) and 3 index bits (D0~D2). The specific depth value and index value can be calculated from the data bits. The maximum depth value of Kinect is about 4000 mm, so that before image preprocessing, a threshold value is set to be 1200 mm ~3500 mm, so as to limit the depth data to 1200 mm~3810 mm.

Meanshift algorithm is used to track the learners' Aerobics actions collected by Kinect sensor. When the meanshift algorithm tracks, it calculates the offset mean value of the current point, then moves the point to the position of the offset mean value of the point, then calculates the offset mean value of the offset point position, and then moves. The iteration will not stop until the end conditions of the iterative algorithm are met. The kernel function is used for nonparametric estimation of meanshift algorithm. There are usually two kinds of kernel functions, unit uniform kernel function and unit Gaussian kernel function. Gaussian kernel function is used in this design. The density of a point can be calculated according to the kernel function.

Many data processed in the field of computer vision are high-dimensional data, and the kernel function used in high-dimensional space is multivariable kernel function. In the  $d$ -dimensional Euclidean space, given  $n$  points  $x_i \in R^d$  and a positive definite  $d \times d$  bandwidth matrix  $H$ , the multivariable kernel density estimation expression is as follows:

$$f_{H,k}(x) = \left(n\sqrt{|H|}\right)^{-1} \sum_{i=1}^n K\left(\frac{x-x_i}{\sqrt{|H|}}\right) \quad (1)$$

There are two kinds of bandwidth matrices, namely diagonal matrix and identity matrix. The formula of identity matrix is as follows:

$$f_{H,k}(\hat{x}) = \left(n\sqrt{|h|}\right)^{-1} \sum_{i=1}^n K\left(\frac{x-x_i}{h}\right) \quad (2)$$

where  $K$  is the kernel function;  $h$  is the bandwidth of the kernel function. When  $K$  is centrosymmetric and has  $K(x) = Q_k(\|x\|^2)$ , where  $x$  is a non negative number,  $K$  can be called a contour function, and  $Q_k$  is a standardized constant coefficient. The formula in the above formula can be changed to the following formula:

$$f_{H,k}(\hat{x}) = \left(nh^d\right)^{-1} Q_k \sum_{i=1}^n K\left(\left\|\frac{x-x_i}{h}\right\|\right) \quad (3)$$

The eigenvalue probability density of the above formula can be calculated by the above formula. When estimating the standard density gradient,  $r(x) = -k'(x)$  can be

set and brought into the above formula to simplify the following mean shift vector:

$$p_k(x) = \frac{\sum_{i=1}^n x_i r\left(\left\|\frac{x-x_i}{h}\right\|^2\right) - x \sum_{i=1}^n r\left(\left\|\frac{x-x_i}{h}\right\|^2\right)}{\sum_{i=1}^n r\left(\left\|\frac{x-x_i}{h}\right\|^2\right)} \quad (4)$$

The mean shift vector is a direction in which the gradient value of probability density increases, and the mean shift algorithm is an iterative algorithm. The iteration window size of meanshift iterative algorithm is fixed. The specific mean shift iterative algorithm is as follows:

- (1) Determine the size, position and shape of the window to be iterated in advance.
- (2) Calculate the center of gravity in the window according to the above iterative algorithm, and determine whether it needs to be weighted according to needs.
- (3) Move the center of the original window to the center of gravity of iterative convergence.
- (4) Continue to calculate the center of gravity at the new center position. That is, repeat the process of (2) until the end condition of convergence iteration is reached, stop the iteration, and this position is the end position of convergence to obtain the final tracking path.

Using the bone motion model demonstrated by the teacher as the template, the Kinect bone tracking path of the students is matched, so as to determine whether the students' actions are correct and correct the aerobics actions.

### 3.2 Recommendation of Aerobics Resources by Neural Network

The network teaching system needs to recommend teaching resources with moderate difficulty based on students' learning level and students' feedback in aerobics movement learning and correction. After receiving students' feedback, the teaching system transmits the data to the resource recommendation module, and the recommendation module retrieves the optimal resources and recommends them to students' users based on the feedback results.

This paper combines the widely used CF algorithm with deep neural network, and proposes a collaborative filtering recommendation algorithm based on deep neural network fusion. The algorithm is used to recommend aerobics personalized teaching resources in the teaching system. The algorithm consists of two main parts. The first part uses the auxiliary information of users and projects, such as resource name, resource description and other specific information, to obtain the initial feature matrix of user projects through deep neural network, in which text attribute features are vectorized by LSTM neural network, and other attribute features are vectorized and input into neural network, Finally, the fusion is carried out through the full connection mode. The second part carries out prediction processing through DBN deep confidence neural network. The initial input is the initial characteristic matrix obtained in the first step, and the output

layer will obtain the user's specific prediction value of the project. Through comparison with the real score, cycle learning until the optimal prediction value is obtained.

In this paper, the deep confidence network DBN is composed of three layers of RBM in series and the last layer of BP neural network. The RBM model is based on state energy, and the current state energy function is shown in the calculation formula.

$$E(z, v; \xi) = - \sum_{i=1}^I \sum_{j=1}^J t_{ij} u_{ij} l_{ij} - \frac{\sum_{i=1}^I (u_i - g_i)^2}{2} - \sum_{i=1}^I s_i l_j \quad (5)$$

In the above formula, the visual layer data is generally represented by  $u$ ; Hidden layer data is represented by  $l$ ;  $T$  represents the weight between the visible layer  $u$  and the hidden layer  $l$ .  $g_i$  and  $s_i$  represent the offset of visual node  $i$  and hidden node  $j$  respectively,  $t_{ij}$  represents the connection weight between the  $i$ -th visual node and the  $j$ -th hidden node, and  $\xi$  is specified as the parameter set. According to the log likelihood probability gradient, the weight update criterion of RBM can be obtained, and the Gibbs sampling method is used to obtain the parameters of DBN depth confidence network. After each iteration completes the pre training process of DBN, the BP feedback neural network obtains the training results, feeds them back from top to bottom, adjusts and optimizes the overall training, uses the minimum mean square error MSE function to detect the error between the predicted score and the real score, and predicts the score according to the highest probability value in the probability matrix, So as to recommend the aerobics resources with the highest score to the corresponding learners, so as to help learners get more targeted learning resources or targeted intensive training.

From the above design content, the software function of Aerobics network teaching system is realized by using artificial intelligence technology, and the software part is transplanted to the system hardware environment, that is, the design of Aerobics network teaching system based on artificial intelligence is completed.

## 4 Test Experiment

The aerobics network teaching system based on artificial intelligence is designed above. This section will test the practical feasibility of the system.

### 4.1 Experimental Contents

Testing the software can effectively ensure the stability of system performance and the perfection of function, mainly including function testing, performance testing and so on. For this system, we first developed the student login and registration function, then further developed the login and registration function of other roles in the system, and then tested the login and registration function. The function of each system component is improved through testing, and the whole system is gradually realized.

After testing the function of the system in this paper, it is completed in the form of comparison in the system performance test. Using the traditional network teaching system as a comparison, the system performance is evaluated by comparing the response rate of the system and the standard rate of students' aerobics movement after the application of the system.

## 4.2 Experimental Results

The main task of function testing is to detect whether each function in the system has been completed, including using the method of unit test to test each functional module in the system, ensure that each functional module can be used normally, and feed back the predicted output. The following table is some examples of testing the system to test whether it meets the functions required by the requirements specification. For example, the test is shown in Table 2.

**Table 2.** User management test cases

Test module	Test content	Expected results	Test result
Application loading	Start Chrome browser; Enter the URL address of the system	The browser displays the system login page	Meet expectations
User login	User name and password are empty	Unable to log on to the system	Prompt user input cannot be blank, please log in again
	Incorrect user name or password	Unable to log on to the system	Prompt the user for input error, please log in again
	After successful login, check the legitimacy of the user entering the page	Users can enter different pages according to different roles	Meet expectations

It can be seen from Table 2 above that the system functions normally and can operate normally.

Response time is the time that the system reacts to the user's input or request. The faster the response time, the faster the response speed of the corresponding system and the better the performance. The movement standard rate refers to the matching degree between students' Aerobics movements and standard movements. The higher the matching degree, the better the teaching performance of the corresponding system. Table 3 shows the response time comparison between the designed system and the mobile teaching system in reference [2] under different conditions and the standard rate of Aerobics movements of students.

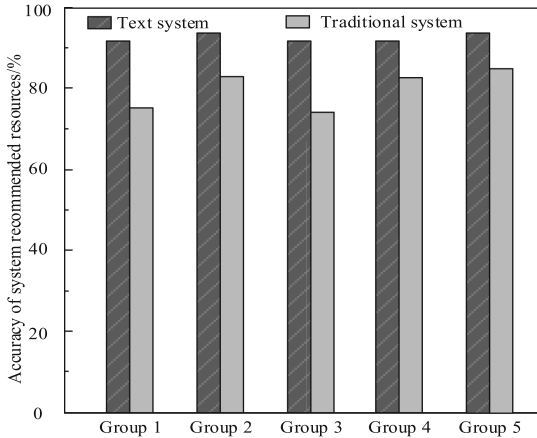
It can be seen from Table 3 that the response time of the system in this paper is shorter than that of the Mobile teaching system, and the response speed meets the actual needs of Aerobics Teaching at present. From the students' movement standard rate, the students' movement standard rate using this system is higher than 90%, which is higher than the highest value of 88.6% of the Mobile teaching system, indicating that the effect of aerobics teaching using this system is better. The main reason is that the control module and peripheral function module are optimized in the design system, which improves the control performance and response speed of the system. At the same time, meanshif

**Table 3.** Function comparison test results

Number of system test users	Paper system		Mobile teaching system	
	Response time/ms	Action standard rate/%	Response time/ms	Action standard rate/%
100	83.9	93.6	244.1	79.1
150	98.8	94.5	325.3	86.3
200	112.9	94.4	389.2	79.4
300	121.7	95.3	4278	80.7
400	128.5	94.2	515.4	88.6
500	130.6	91.1	686.6	84.5

algorithm is used to track the students’ bone information collected by Kinect, so as to achieve the purpose of correcting Aerobics movements and improve the standard rate of students’ movements.

Figure 3 below shows the accuracy comparison between students’ needs and system recommended resources when students use the system. In the comparison process, students of a university are divided into 5 groups with 20 people in each group to make targeted recommendations.



**Fig. 3.** Comparison of accuracy of system recommended resources

It can be seen from Fig. 3 that when students in each group use the two teaching systems, the accuracy of the recommended resources recommended by the system in this paper is relatively higher, higher than 90%. In this paper, the improved neural network recommendation algorithm is used to recommend the teaching content, which can accurately eliminate the influence of other factors, and the recommended resources can better meet the needs of students to learn aerobics.

Above all, the aerobics network teaching system based on artificial intelligence designed in this paper has good operation and practical application effect.

## 5 Conclusion

Aerobics is a popular sport. As one of the important contents of physical education curriculum, it is also welcomed by students. Influenced by the obvious fitness effect and easy to learn characteristics of aerobics, many scholars at home and abroad have designed and developed the aerobics network platform, but most of the people whose platform design is aimed at are fitness enthusiasts of non professionals in society, which is not suitable for campus aerobics course teaching. By deepening the application, we can give play to the role of information technology in education and teaching reform and development, Relying on educational informatization, accelerate the construction of learner centered teaching and learning methods. Therefore, this paper designs an aerobics network teaching system based on artificial intelligence from two aspects: hardware control module and peripheral function module optimization, software part calibration of aerobics movement and recommendation of aerobics teaching resources. The performance of the system is tested to verify the feasibility of the system being put into teaching. In the actual aerobics teaching, the use of the system effectively enhances students' interest in learning, improves the effect of Aerobics network teaching, and improves the teaching disadvantages of traditional aerobics teaching. In the next step, the specific aerobics teaching courses will be classified and taught to further improve the teaching quality.

## References

1. Zhang, Y.: Mobile live broadcasting platform for aerobics video teaching based on Android. *Inf. Technol.* **44**(05), 41–44+53 (2020)
2. Li, X., Wu, Q.: Research on optimization design of modern apprenticeship teaching system applied to multimedia network video technology. *J. Chongqing Inst. Technol.* **33**(03), 174–179 (2019)
3. Xu, Y., Jin, G.: Artificial intelligence matching simulation of targets in multi-feature cascaded image database. *Comput. Simul.* **38**(03), 437–441 (2021)
4. Zhu, M., Shen, J., Wang, J.: The design and implementation of a scalable Internet of things teaching development system. *J. East China Normal Univ. (Nat. Sci.)* **2021**(03), 78–95 (2021)
5. Zhang, Z., Chen, J.: Construction practice of cloud experiment teaching system for information security specialty based on cloud platform. *Exp. Technol. Manage.* **38**(09), 251–255 (2021)
6. Zeng, H., Wang, Z., Qiu, C.: A study on building a model of artificial intelligence teaching application based on meta-module method. *China Educ. Technol.* (11):71–76+87 (2021)
7. Zhang, J., Li, C., Zhu, Y.: Massive video teaching resource management system based on cloud platform. *Mod. Electron. Tech.* **43**(21), 151–155 (2020)