



Construction of Multimedia Online Education Platform Based on Fuzzy Neural Network

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Abstract. The current multimedia online education platform has low resource utilization and response rate. In order to effectively solve this problem, this paper will study the construction of multimedia online education platform based on fuzzy neural network. The hardware framework of online education platform is built with FPGA as the control core, and the platform resources are mined and processed by fuzzy neural network. Use cloud computing to design platform resource scheduling and improve platform operation efficiency. Through experiments, it is verified that the recommendation accuracy of the platform is higher than 90%, the response rate and processing speed of the platform are significantly improved, and the practical application effect is better.

Keywords: Fuzzy neural network · Multi-media · Online education platform · Data mining · Resource scheduling · Cloud computing

1 Introduction

In the information society where knowledge is updated rapidly, the aging speed of information and knowledge is unprecedented. In recent years, with the rapid development of Internet technology and the large-scale popularization of smart terminal devices such as smart phones and tablets, and mobile network resources such as 3G and 4G are no longer scarce, digital and mobile online learning methods have become more and more popular for people. Accepted, at the same time, more and more traditional education institutions and Internet companies are involved in the field of online education. The construction and use of online education platforms have promoted profound changes in the field of education. Universities, middle schools, and large educational institutions have established modern education information platforms such as digital book information systems and Internet education platforms. Learners can not only use traditional classroom teaching Learning in the form of learning, and as long as you have a networked computer or other handheld terminal, you can enter the network online platform to achieve the purpose of learning [1]. Online education has the characteristics of fragmented learning time, unlimited learning locations, and targeted learning content. Online education has the advantages of being able to choose learning content according to one's own needs, and being able to watch and study repeatedly for many times. It not only affects the learning

effect of users, but also promotes the transformation of traditional education mode. The development of multimedia communication has always been the driving force of modern distance education systems. The role of an online education platform is indispensable. It not only needs to collect, edit, and store abundant learning resources, but it also needs to respond to massive user requests efficiently in real time. However, there is still a big gap between the development of modern distance education in my country and the distance education in developed countries. Generally speaking, my country's distance education platforms generally lack innovation.

Reference [2] analyzes the current situation and difficulties of cyberspace security offense and defense practice teaching, designs a virtual and real cyberspace security offense and defense platform that integrates traditional information security and industrial control system security, and gives a specific construction plan. The experimental platform can meet the cyberspace security practice training needs of professional postgraduates, and has strong practicability and scalability. Reference [3] aims at the defect that the online teaching platform based on the ADDIE model of classical teaching design theory fails to reveal the complexity of online practical teaching activities, and uses advanced ubiquitous technology to build an ubiquitous practical teaching activity model based on activity theory and situational perception. Based on the Internet of things and sensor technology, the state evolution diagram method of experimental process is adopted to create an ubiquitous practical teaching platform with the ability of dynamic generative data acquisition in experimental process. Through reasonable teaching activity design and practical evaluation, it is proved that the online platform can complete the teaching task, avoid the result oriented experimental evaluation, and effectively improve the online teaching effect of practical courses. However, the recommendation accuracy of this platform is low, and the practical application effect is not good. Reference [4] summarizes the problems of users' online learning experience on online learning platforms by analyzing the current status of multimedia online education platforms and online learning behavior characteristics of online learning users, combining quantitative and qualitative analysis of users' questionnaires, interviews and surveys, and according to the user journey map of online learners. Then combined with the FBM behavior model proposed by Stanford University behavioral science professor Fogg, the interactive design method of multimedia online education platform under the FBM behavior model is obtained from the three aspects of enhancing user motivation, improving user ability and increasing trigger mechanism. However, the response rate of the platform is low after its application. Reference [5] focuses on the key technologies of Android development, database design and personalized recommendation algorithm based on the design and analysis of the overall architecture, functions and execution process of the multimedia online education platform using Android platform and C/S structure, combined with SQLite database, this paper realizes the construction of multimedia online education platform. However, the platform has the problem of low processing speed, and the actual application effect is not good.

Neural network has parallel processing ability and strong fault tolerance. However, there are obvious deficiencies in the expression of knowledge and the interpretation of the rules learned. Fuzzy logic and neural network are related and complementary in many aspects. Therefore, fuzzy logic system and artificial neural network are combined

to learn from each other. The combination of fuzzy logic and neural network produces fuzzy neural network. It has the advantages of fuzzy logic system and neural network, has the function of universal approximator, has clear physical meaning, fast convergence speed and higher processing efficiency. Therefore, according to the above analysis, this paper will build a multimedia online education platform based on fuzzy neural network.

2 Construction of the Hardware Part of the Multimedia Online Education Platform

When put into large-scale actual use, there will be higher hardware requirements, and the software must be supported by the hardware, and the combination of software and hardware can complete various functions, so the hardware part must also be considered. The material foundation supporting the multimedia online education platform is an actual computer network, which is similar to the current network center structure in schools at all levels. The functional modules of the software are placed on the public network. And as a general-purpose online education platform, depending on the number of students to be supported, the scope, the way students access the Internet and many other factors, its hardware structure will change greatly, and the organizational structure may also be different, but generally speaking, they all have the following functional modules: access module, exchange module, server module, two-way interactive synchronous teaching module, courseware development module, etc. According to the implementation requirements of the functional modules, the overall framework of the hardware part of the multimedia online education platform designed in this paper is shown in Fig. 1 below.

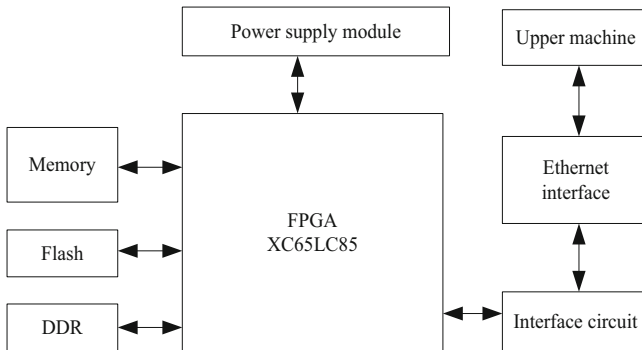


Fig. 1. The hardware framework of the multimedia online education platform

The hardware core controller of the multimedia online education platform designed above is FPGA chip. The structure of FPGA is flexible. Its logic unit, programmable internal wiring and I/O unit can be programmed by users, which can realize any logic function and meet various design requirements; It has the advantages of high speed, low power consumption and strong universality, and is especially suitable for the design of

complex systems; FPGA can also realize dynamic configuration, online system reconfiguration, hardware softening, software hardening and other functions; At the same time, FPGA can allow the function of the circuit to be changed as needed at different times of system operation, so that the system has a variety of space related or time-related tasks [6]. The platform communicates with the host computer of the platform through Ethernet interface or JTAG structure. The design content of the hardware part will be described in detail below.

2.1 Hardware Core Control Module Design

The core control circuit board uses a 50 MHz single-ended CMOS crystal oscillator, and the clock signal is connected to the global clock pin, which can be multiplied to a higher operating frequency through the DCM or PLL in the clock management module; the memory system includes 1 GB of DDR2 SDRAM Chip, 128 Mbit SPI Flash chip, 16 Mbit Nor Flash and 128 Mbit Nand Flash. Among them, SPI Flash is used as the configuration memory when FPGA is powered on and used to store FPGA configuration files; DDR2 SDRAM is mainly used to execute the code of the main program when running the embedded operating system; Nand/Nor Flash is used to store embedded operations System programs such as the kernel, drivers, and file system of the system. The interfaces on the core control board are mainly Ethernet interfaces based on the DP83848 network card chip, and USB based on the FT2232H chip. JTAGAJART interface.

According to the FPGA chip configuration mode scheme in Table 1 below, select the hardware FPGA configuration mode pins that meet the education platform.

Table 1. FPGA chip configuration mode selection scheme

Pin P1 level	Pin P2 level	Composite clock	Output bus width	Configuration mode
0	0	FPGA output	8/16	Main Select MAP configuration mode
0	1	FPGA output	1/2/4	Main serial port/SPI configuration mode
1		FPGA input	8/16	Configure mode from Select MAP
1	1	FPGA input	1	Configure mode from serial port
—	1	TCK input	1	JTAG test configuration

This platform mainly adopts two configuration methods, JTAG and SPI Flash. The combination of these two methods can not only ensure the characteristics of the “soft” and hardware design of the experimental platform, but also ensure the ease of operation in the experimental link. Configure the FPGA through SPI Flash. SPI Flash is a non-volatile

storage device. After the configuration mode of the FPGA chip is set, the configuration file will be automatically loaded from SPI Flash after the system is powered on.

2.2 Serial Port Module Design

The circuit uses STM32 serial port to supply power through MAX232 level conversion chip. MAX232 is a charge pump chip that can complete two TTL/RS232 level conversions. Two serial ports are used in the system. USART1 is used to collect the serial data of the device, and USART2 is used as the operating system terminal output, which is convenient for viewing and debugging internal programs. The running situation. This platform uses the USART multiplexed I/O ports PA9 and PC10 as serial port sending pins, configured as push-pull output with a speed of 50 MHz; USART multiplexed I/O ports PA10 and PC11 are used as serial port receiving pins, configured as floating input.

In addition, the asynchronous communication interface of FPGA supports the connection of 8- and 16-bit wide asynchronous memory devices, such as NOR Flash, NAND Flash and dual-port RAM. It has two main operating modes: WE trigger and selective trigger. The difference between the two trigger modes is listed in Table 2 [7].

Table 2. Trigger mode of asynchronous communication interface

Trigger mode	Trigger function	Asynchronous access operation
WE trigger mode	Write trigger	Always active during asynchronous access
Select trigger mode	Byte enable	Only activated during the trigger phase of a visit

Using the address latch of CPLD, expand 7 high address lines AA11–AA17 through I/O port to connect with A11–A17 of FLASH respectively, thereby defining refresh rate, CAS delay and many SDRAM timing parameters.

2.3 Storage Module Design

The external storage module, that is, off-chip SRAM, uses IS61LV25616 SRAM chip from ISSI. Its storage capacity is $16 * 256K$, and it has high and low selection signals. Features are as follows: access time is 10 ns, 12 ns, supports tri-state output, fully static operation does not require clock or refresh, interface level is compatible with TTL standard, independent 3.3 V power supply, high byte data and low byte data can be controlled separately. This module is mainly used to buffer the collected data. Since the system communication cycle is one second, it only needs to buffer the data for two seconds. The size and access speed of the SRAM meet the performance requirements of the platform. On the above platform hardware, the fuzzy neural network is used to design the platform software part to complete the construction of the overall multimedia online education platform [8].

3 Partial Construction of Multimedia Online Education Platform Software Based on Fuzzy Neural Network

3.1 Fuzzy Neural Network Mining Multimedia Online Education Resources

Fuzzy neural network is the product of the combination of fuzzy theory and neural network. It combines the advantages of neural network and fuzzy theory, and integrates learning, association, recognition and information processing. In this paper, the network is applied to the process of multimedia online education resource mining. The input is a large education database resource, which is obtained by crawler technology, and the input is the mining result of multimedia online education resources. The performance of the fuzzy neural network is improved by using the fuzzy inference layer. The fuzzy neural network designed in this paper consists of an antecedent network and a consequent network. The antecedent network is used to match the antecedent of fuzzy rules, and the consequent network is used to generate the consequent of fuzzy rules [9]. The front network consists of three layers, of which the first layer is the input layer; In the second layer, each node represents a language variable, which is used to calculate the membership degree of the input component belonging to the fuzzy set of each language variable; The third layer is used to normalize the excitation and calculate the activation degree of each rule. The latter network is composed of parallel subnetworks with the same structure, and each subnetwork produces an output. The consequent network is generally divided into two layers. The first layer calculates the consequent of each rule, and the second layer calculates the network output, using the back-propagation learning algorithm. The adjustable parameters in fuzzy neural network are mainly concentrated in the first layer and the fifth layer. The parameters of the first layer are the membership function parameters, and the parameters of the fifth layer are the subsequent parameters of the rule, that is, the parameters of the part of the if-then rule. The functions of each layer are described in detail below.

The first layer of the fuzzy neural network converts the input vector into the membership degree of the corresponding fuzzy set, and the node i in the layer is an adaptive node composed of membership functions [10]:

$$\begin{aligned} Out_i^1 &= u_{Q_i}(x), i = 1, 2 \\ Out_i^1 &= u_{P_{i-2}}(y), i = 3, 4 \end{aligned} \quad (1)$$

In the above formula, Out_i^1 is the degree of membership of fuzzy set $F = \{Q_1, Q_2, P_1, P_2\}$, which determines the degree of a given input or satisfaction. The membership function of neural network in this research is Gaussian function. The second layer of the network is a paradigm operator that performs fuzzy AND on the input variables.

$$Out_i^2 = u_{Q_i}(x)u_{P_j}(y), i = 1, 2; j = 3, 4 \quad (2)$$

The third layer performs normalized excitation processing on the input, and the output of the third layer is the ratio of the excitation intensity of the first and second rules to the sum of the excitation intensities of all rules calculated for the i node.

$$Out_i^3 = u_i(u_1 + u_2)^{-1}, i = 1, 2 \quad (3)$$

The fourth layer is the output of calculating fuzzy rules, where \bar{u}_i is the standardized excitation intensity output by the third layer.

$$Out_i^4 = \bar{u}_i(a_ix + b_iy + c_i), i = 1, 2 \tag{4}$$

Among them, (a_i, b_i, c_i) is the parameter set of the fuzzy rule consequence, which is called the rule consequence parameter. The fifth layer sums up each output to get the total output. The fuzzy neural network uses a combination of backpropagation algorithm and least square method for learning and training. Figure 2 below is the training flowchart of the fuzzy neural network.

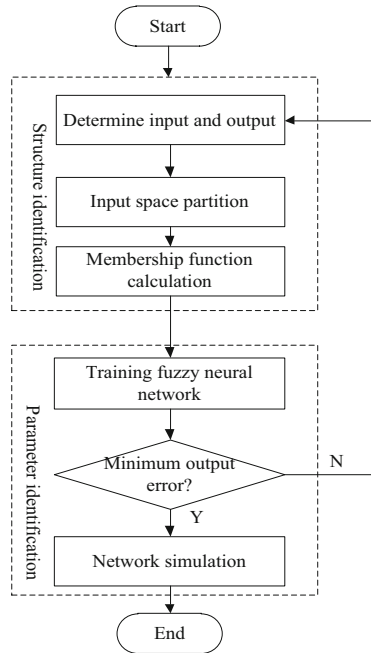


Fig. 2. Flow chart of fuzzy neural network training

Among them, structure identification is to set the structure of the network, mainly determine the input and output variables of the model from the following aspects, obtain the optimal combination of input and output variables, and determine the division of input and output space, the number of rules, the number of membership functions and the initial parameters of membership functions. Parameter identification refers to the identification of a group of parameters under the determined structure, adjusting each parameter in the model to obtain the optimal model parameters of the system. In the process of parameter identification, it mainly depends on network training to judge the training error. The parameters that meet the minimum training error are used to mine multimedia educational resources.

Firstly, the resource extraction of statistical analysis is carried out for the large database of multimedia educational resources. Make statistics on the preferences of different educational objects for educational resources, and conduct generalization operations to form a data warehouse. After data cleaning, the multimedia education resource data is integrated, and the mapping method is used to transform the non numerical data into numerical data. After the maximum and minimum normalization method is used to normalize the input data, the multimedia education resources are mined by using the fuzzy neural network established above, and stored in the education platform database according to the established data labels.

3.2 Platform Resource Scheduling Model Design

The users of multimedia teaching platform include teachers and students of the school and visitors outside the school. In some time periods, the amount of concurrent visits is huge. In order to improve the service performance of the platform, cloud technology is used for platform education resource scheduling. Based on the idea of cloud computing and computer resource virtualization, the cluster server module of the platform is designed, and its structure is shown in Fig. 3.

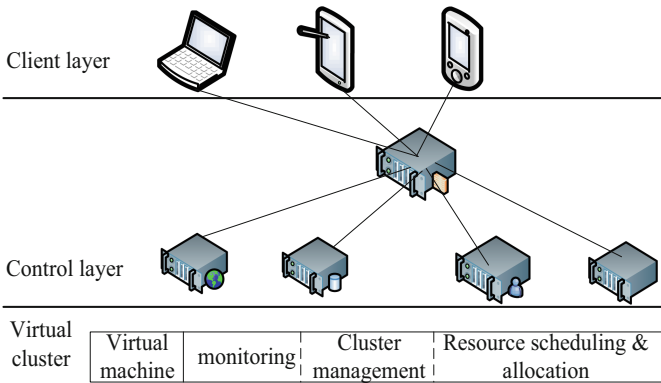


Fig. 3. Virtual resource service cluster architecture diagram

The virtual resource service cluster is divided into three levels from top to bottom: consumption layer, control layer and virtual cluster layer. The consumption layer refers to various client resource access requests forwarded by the Web master server; The control layer consists of two parts: one is the basic resource data distribution server, which realizes the multimedia teaching function of the system; the other is the load balancing control server, which realizes the scheduling and task allocation of the data distribution server according to the load balancing algorithm; The virtual cluster layer is based on the virtualization technology in cloud computing, combined with high-speed resource transmission technology, high-capacity storage technology, dynamic scheduling technology, etc., uses various existing resources to build a large number of schedulable virtual machine resources, and provides resource support for multimedia teaching according to needs [11].

Considering the indicators of its parallel operation; In the process of resource service operation, not all resources are called evenly. In many cases, most teaching on demand focus on a small number of resource files. Therefore, in the case of limited service resources, if most resources are allocated to more intensive service requests, the service efficiency will be improved on the whole. Predict the virtual CPU utilization according to the following formula:

$$\eta_{vcpu}(t) = 1 - t_f \cdot t_{to}^{-1} \quad (5)$$

Among them, t_f is the idle time of the education platform; t_{to} is the total time of the overall platform for scheduling resources.

Using the collage theorem and separate interpolation method to analyze and process the above formula, the general prediction formula can be obtained as follows:

$$\eta_{vcpu}(t) = \bigcup_{i=1}^{t-1} C_i(D) \quad (6)$$

Among them, C_i is the affine transformation obtained by the principle of statistics; D is the collection of all platform resource scheduling data on the time axis.

The impact of resource data measurement and statistics in a small time interval on the working state change of the CPU itself and the process state change caused by the platform scheduling tasks based on the process queue. In order to eliminate these effects, the virtual CPU occupancy can be calculated by weighted average, as shown in the following formula:

$$\begin{cases} \bar{\eta}_{vcpu}(t) = (1 - \lambda)\bar{\eta}_{vcpu}(t - 1) + \lambda\eta_{vcpu}(t) \\ \eta_{vcpu}(0) = 0 \end{cases} \quad (7)$$

In the above formula, λ is the weight, and its value range is $[0, 1]$, which is used to control the proportion of the historical virtual CPU occupancy rate value in the current occupancy rate prediction. The value of λ can be dynamically adjusted according to actual needs. When the virtual node is running, the tasks of the virtual central processing unit need to be allocated to each thread of the actual physical central processing unit to run, thereby realizing efficient scheduling of platform resources. Combining the above design content of platform hardware and software, completed the research on the construction of a multimedia online education platform based on fuzzy neural network.

4 Experimental Research

A multimedia online education platform based on fuzzy neural network is constructed above, and the feasibility and application of this online education platform will be studied in an experimental manner.

4.1 Experiment Content

When CPU is The 10 core Intel Xeon e5–2640 CPU, the operating system is tested in the window 10 computer, and the simulation software is Matlab 7.0. Conduct comparative experiments on multimedia online education platforms to obtain more objective experimental results. The multimedia online education platform based on fuzzy neural network constructed in this paper and the online education platform constructed by ADDIE model are compared with the three indicators of response rate, transmission rate and personalized resource recommendation accuracy rate of the platform, so as to comprehensively analyze the performance of the education platform.

4.2 Experimental Results

Figure 4 shows the comparison of personalized resource recommendation accuracy of the platform.

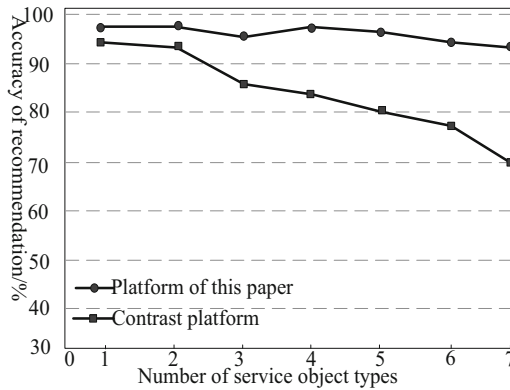


Fig. 4. Accuracy rate of personalized resource recommendation

Analyzing Fig. 4, it can be seen that with the continuous enrichment of platform service object types, the resource recommendation accuracy rate of the comparison platform has decreased, and the recommendation accuracy rate of the platform in this article is still higher than 90%.

Table 3 below shows the test results of the response rate and transmission rate tests on the two educational platforms. Among them, the change of experimental variables is controlled by changing the service request accepted by the platform.

Table 3. Comparison of platform response rate and transmission rate

Service request volume	This article platform		Comparison platform	
	Response time/ms	Transmission time/ms	Response time/ms	Transmission time/ms
100	306.4	98.8	518.2	119.8
150	317.9	98.5	541.5	114.3
200	328.6	99.1	603.2	117.9
250	338.3	98.9	633.6	117.5
300	366.5	99.3	643.7	120.8
350	370.9	97.8	665.3	116.6
400	504.1	98.6	865.1	119.2
450	530.7	98.9	898.5	114.5
500	665.9	99.2	942.4	127.9
600	689.6	98.7	972.9	128.9
700	845.9	99.4	1053.8	128.4
800	859.2	99.0	1069.1	137.7
900	901.5	99.4	1301.4	144.6
1000	979.8	98.1	1378.6	145.5
Average value	571.8	98.8	863.4	125.3

Analysis of the data in Table 3 above shows that with the increase in service requests, the response time of the two education platforms has shown an increasing trend, but the response time of the education platform in this article is far less than that of the comparison platform. Calculate the average service request response time of the two platforms in this experiment. The average response time of the platform in this paper is 571.8 ms, and the average response time of the comparison platform is 863.4 ms. The response time of the platform in this paper is shortened by about 33%. Analyzing the transmission rate of the platform, the transmission time consumption of the platform in this article has remained relatively stable, while the comparison platform has been increasing. Therefore, it can be determined that the education platform constructed in this article has a higher response rate and transmission rate.

In summary, the fuzzy neural network-based multimedia online education platform constructed using the research in this article has the advantages of responsiveness, fast transmission speed and accurate resource recommendation.

5 Conclusion

The online education platform will cover a variety of terminals with a variety of emerging communication channels. It combines multimedia technology, computer technology and communication technology to transmit audio, video, graphics, animation, text and

other media information to different places. Modern distance education has rich teaching resources, flexible teaching methods, and is not limited by time and space, so that students can quickly obtain knowledge in a relaxed and happy atmosphere. The continuous enrichment of multimedia teaching technology promotes the development of education and teaching. In order to meet the needs of multimedia education, this paper studies and constructs a multimedia online education platform based on fuzzy neural network. FPGA is used as the control core to build the hardware framework of the online education platform, and fuzzy neural network is used to mine the platform resources. Use cloud computing to design platform resource scheduling and improve platform operation efficiency. Through experiments, the educational platform is tested, and it is verified that the platform has the advantages of high transmission rate, high response rate and good resource provision, and can meet the needs of multimedia education. However, there are too few indicators verified during the experiment, which leads to the decline of the reliability of the multimedia online education platform. Therefore, in the future, it is necessary to use more indicators to verify the performance of the multimedia online education platform, and introduce advanced technologies to optimize the platform, in order to improve the effect of multimedia online education and promote the further improvement of modern education level.

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