Intelligent Computer Aided Instruction System Based on Cloud Computing

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Abstract. The traditional teaching assistant system can only count the teaching data. The teaching assistant function is single, and it can not support the large concurrent demand. To solve the above problems, an intelligent CAI System Based on cloud computing is designed. Taking embedded microprocessor as the core design, 5G communication and other functional modules are added as the system hardware. In order to meet the high concurrent operation requirements of the system, the cloud computing module is arranged to solve the problem of single teaching auxiliary function. By establishing students' knowledge map, Bayesian inference network is used to recommend learning resources. According to the auxiliary teaching function, the system database is designed to meet the needs of supporting a large amount of concurrency. Through the comprehensive performance test of the computer-aided instruction system, it is verified that the response rate of the designed system is increased by nearly half, and it has the corresponding function to meet the modern teaching assistance. The practical application of the computer-aided instruction system has a good effect.

Keywords: Cloud computing · Intelligent computer system · Auxiliary teaching system · Microprocessor · Knowledge atlas · Bayesian inference network

1 Introduction

With the increasingly significant role of computer in teaching, the development and application of traditional multimedia CAI system are confined by its own limitations and closure, resulting in less application of CAI System in practical teaching. Computer assisted instruction is to simulate the teacher's behavior with computer, and achieve the teaching purpose through the interaction between students and computer [1]. At present, the computer-aided teaching system commonly used can not update the teaching content at any time, students can not feed back the difficulties encountered in learning to teachers when using the teaching assistant system, and the traditional computer-aided teaching system ignores the gap between different students, resulting in unsatisfactory teaching effect. Therefore, it is necessary to improve and optimize the CAI system. Reference [2] studies the teaching and training platform of marine supply virtual equipment under Web3D technology by using web technology, and streams and downloads the compressed

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data through HTTP protocol. At the same time, the software seven layer switching strategy is used to deal with the high concurrent access on the network. This teaching platform has good practical teaching effect, but it has high requirement for hardware support. Reference [3] uses augmented reality technology and uses interactive numerical method to optimize it, and designs augmented reality teaching system. The system can build a more realistic teaching scene for students, but there are still some limitations in practical use.

With the deepening of network technology and the popularization of network applications, the combination of computer-assisted instruction system and it has made great progress. Cloud computing has become a global hot spot. It has developed rapidly and continuously affected people's life, study and work. Cloud computing has become the third wave of technological reform since the emergence of the Internet [4]. With the accelerated development of cloud computing services and the continuous expansion of the scale of parallel jobs, cloud service providers have expanded the number of underlying computing, storage and communication components in their data centers to ensure that the performance, reliability and cost-effectiveness of applications reach the expected level. According to the above analysis, this paper will design an intelligent CAI System Based on cloud computing to help teachers teach according to students' cognitive ability and interest characteristics, so as to greatly improve the teaching effect.

2 Hardware Design of Intelligent Computer Aided Instruction System Based on Cloud Computing

Before building the hardware development environment, we should plan the overall architecture of the whole system, and use the module design method to subdivide the system into several modules, and finally implement them one by one. The main parts of the hardware environment of the intelligent computer aided instruction system designed in this paper are 5G module design and embedded microprocessor. Modular design of system hardware is adopted, which mainly consists of these modules: memory unit,

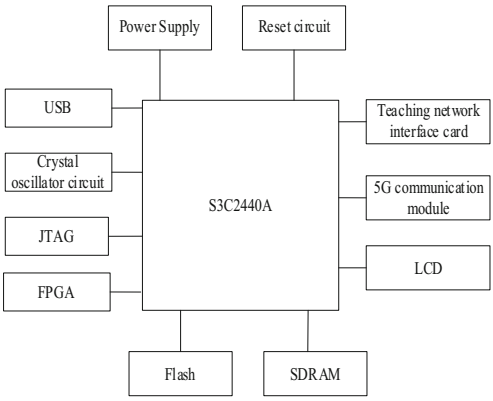

Fig. 1. Overall framework of intelligent computer aided instruction system

wireless network support, I/O port, embedded processor and peripheral devices [5]. Figure 1 is a schematic diagram of the overall framework of the intelligent computer-aided instruction system designed in this paper.

2.1 Processor Module Design

The hardware controller of the teaching assistance system designed in this paper uses S3C2440A microprocessor, which has ARM920T core and implements MMU, AMBA, BUS and Harvard cache architecture. S3C2440A internally integrates rich system resources, including: 4-channel DMA with external request pins, 3-channel UART, 2-channel SPI, 1-channel IIC interface, USB interface, LCD controller, external storage controller, 4-channel PWM timer and 1-channel internal timer, RTC, PLL on-chip clock generator, ADC and touch screen interface, etc. S3C2440A has 130 pins. In this design, 67 of them are used, including the pins of power supply, crystal oscillator and reset circuit used in the minimum system, as well as the pins needed for storage, network card, USB and external teaching auxiliary hardware. The supply voltage of the chip is 3.3 V and crystal oscillator of 12 MHz [6]. LDATA0 interface between microcontroller and NOR Flash, flash memory chip is K9F1208, the operating voltage of the memory is 2.7–3.6 V, internal use of paging mechanism for storage, K9F1208 read and write in page unit, erase data in block unit. Code is usually run directly in NOR Flash rather than having to be copied to RAM for execution, which increases execution efficiency.

S3C2440A microprocessor is connected to FPGA chip, and the transmission and processing of RF communication signal are realized by FPGA. By using the overlapping and adding characteristics of rf signals, the serial output data is not so long, which makes full use of the subcarriers added in the frequency domain expansion. The FPGA control sliding window for signal sampling, sliding window step is 32, so the first all the way with enabling signal transmission, behind each data transmission delay in turn 32 length, and because the complete IFFT output for 256, eight times that of step, and no parallel match exactly, the next cycle of symbols and transmission according to this rule.

The high-speed signal acquisition module mainly consists of signal conditioning and high-speed sampling. Signal conditioning mainly includes differential conversion circuit and anti-aliasing filter circuit. High - speed sampling mainly includes sampling circuit and clock circuit. The AD sampling chip AD9517, under the control of FPGA controller, collects the communication signals of each functional module in the operation process of the auxiliary teaching system and the students' teaching feedback with the teachers by using the system terminal to realize the communication in the teaching process.

2.2 Communication Module Design

If signal sent from rf front-end module is single-end signal, which is converted into differential signal through differential conversion circuit first, which improves the anti-interference ability of signal in transmission process, and then carries out anti-aliasing filtering. The data at the transmitter end after framing is sent to the antenna through the operation of the RF part of FPGA, and the receiving antenna of NI USRP-RIO and the clock module control antenna receive the data. The received data is converted into baseband data through down conversion, and the first step is to do synchronous processing

to remove the noise field. Although one of the features of FBMC is that it abandons orthogonality between subcarriers and does not require strict synchronization, the first synchronization discussed is air-port synchronization in a wireless system, allowing the receiver antenna to separate valid data from noise.

Signal transmission in the analog channel is bound to be mixed with some unknown high frequency interference signals, after turn single-ended difference signal and the unwanted signal components and noise, and can't directly to the signal sampling, require the use of anti aliasing filter for filtering processing, maximum limit to restrain or eliminate the spectrum aliasing phenomenon, Avoid in-band aliasing and dynamic performance degradation [7]. The anti-aliasing filter used in this design is a bandpass filter.

The ADS5474's 400 MHz LVCMOS sampling clock is produced by the AD9517. The AD9517 is a clock management chip with four pairs of configurable parallel clock outputs. Includes two pairs of 1.6 GHz LVPECL outputs (each pair of clock outputs shares a 1 to 32x crossover) and two pairs of 800 MHz LVDS/CMOS outputs (each pair of clock outputs shares two serial 1 to 32x crossover); On-chip VCO adjustable frequency 1.45 GHz to 1.8 GHz; The AD9517 chip requires FPGA to configure its internal registers through SPI, and the signal line includes serial data (SDIO/SDO), clock signal (SCLK) and enable signal (CS_N). The SPI interface of the clock chip AD9517 is compatible with most synchronous transmission protocols, allowing the register of AD9517 to read/write operations, supporting single or multiple byte transmission, supporting MSB or LSB before transmission mode; The SPI interface can be configured as either a single wire bidirectional mode I/O interface (SDIO) or two unidirectional mode I/O interfaces (SDIO/SDO). By default, it is in single-line bidirectional mode. Serial shift clock input signal SCLK is used to synchronize SPI interface read/write operations, such as write operation on rising edge and read operation on falling edge [8] (Fig. 2).

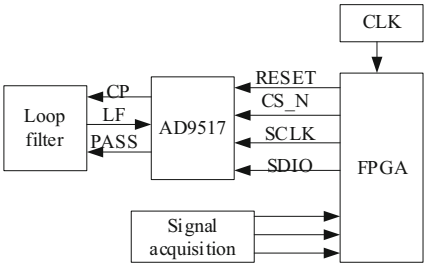

Fig. 2. Signal sampling clock circuit

When the FPGA and AD9517 are powered on, the FPGA first gives the AD9517 reset pin (RESET_N) a low pulse, and its internal register is set to the default value. When the enable signal (CS_N) is pulled down, the INTERNAL register of AD9517 can be configured through SPI to set its output clock size, level standard, etc.

The output data D[13:0] and the accompanying clock DRY± of the ADC chip selected in this paper are LVDS differential signal standards, and the data transmission mode is DDR (double data rate data transmission, data transmission at the same time of

the rising edge and falling edge of the clock) transmission mode. The LVDS level of the data is connected to the HR I/O bank of the FPGA, and the 100 Ω terminals required for LVDS signals are added to the FPGA reception logic. Low power management of gateway boards is controlled by MOSFET. The main control chip can control the power supply of THE 5G module through 5G EN control signal.

The student terminal and the system realize the end-to-end data transmission through TCP/IP network protocol. In the system, the TCP/IP receiver program of the server and client will always run in the background, waiting to receive the data from the edge and server. When the edge end responds to the request, the TCP/IP sending function in the edge end is automatically called. After the connection is established, the related data can be sent to the server. After receiving the data and saving the data to the corresponding directory, the server runs the TCP/IP receiving function again and waits to receive the data.

With the hardware part of the intelligent computer-aided teaching system designed above as the support frame, cloud computing and other technologies are used to realize the intelligent assistance to the teaching process, so as to provide the functions required by teaching activities.

3 The Software Design of Intelligent Computer Aided Instruction System Based on Cloud Computing

3.1 Cloud Computing Module Design

The establishment of the auxiliary system supported by cloud computing helps learners to extend and expand their learning time and teaching space. The whole virtual cloud architectures need to build the cloud cluster environment as a whole system of data storage and operation center, through virtualization software integration server resources to form a resource pool and multiple virtual one unified allocate these resources installed a different operating system virtual desktop, students end USES a terminal connected to the network optical switches and access their virtual desktops.

Six servers, including the Active Directory domain controller, SQL server, vcenter server, Composer server, and Connection server, are required to set up enterprise-class virtual desktops. When deploying the cloud computing nodes of the teaching assistance system, the problem of energy consumption under large-scale and high-concurrent operations needs to be considered. Provide fault tolerance for task failure while minimizing energy consumption. In this paper, an energy saving and reliable task replica deployment algorithm, RER, is proposed. The algorithm takes a task replica running at low speed and allows multiple task replicas to share the same server resources.

Different servers have different free time, and different task copies have different execution time sizes. Assume that the task copy scheduling process will use N servers to execute all $|T_S|$ task copies, with $N = |T_S|$ initially, and each master task deployed separately on a master server. Before the algorithm is implemented, the server and the task copy are sorted in non-ascending order according to the idle time and the task copy execution time respectively, so as to avoid repeated sorting during the algorithm [9]. The optimization objectives are as follows:

$$F = \min \sum u_s \tag{1}$$

In the formula, u_s indicates server d_k yes (=1) No (=0) is used. The optimization constraints of the above formula are as follows:

$$N_s = \begin{cases} 1, 1 \le k \le |T_S| \\ \min\{1, \sum N_s\}, k > |T_S| \end{cases} \tag{2}$$

$$\mu_k = \begin{cases} Q, k > |T_S| \\ Q - S(T_k), 1 \le k \le |T_S| \end{cases} \tag{3}$$

In the formula, μ_k is the idle time of server d_k; Q is the estimated completion time of the operation; N_s is the number of servers used in cloud computing; $S(T_k)$ is the time at which a copy of task T_k is executed at the maximum processing rate of the server. If the response speed of each main task is known when the cloud computing server provides corresponding services, tasks can be allocated according to the idle degree of the cloud computing service to improve the concurrent processing efficiency.

3.2 Recommended Design of Teaching Resources

For the teaching assistant system, in order to obtain better teaching effect, the auxiliary system needs to be able to personalized teaching resources according to the teaching feedback of students. To this end, knowledge graph is established and bayesian network is used to recommend learning resources for students. According to the information collected when students use the system functions to learn, the corresponding entities are extracted to establish the knowledge map. BiLSTM+CRF model is used for entity recognition in this paper, which consists of three layers. The first layer of the model is the look-up input layer, which converts sentences into word vector and word vector. The second layer is the double-layer LSTM layer, which is to input word vector and word vector in BiLSTM, and then output the scores of all labels of each word in the sentence. The third layer is the sequence annotation layer, which takes the output of the bidirectional LSTM layer as the input and finally obtains the probability value of the tag sequence. The bidirectional GRU model is used for relational extraction of the entities extracted in the previous step. According to the different requirements of the education syllabus for teaching knowledge, the weight of knowledge points is divided into understanding, understanding, mastery and application, and the weight is given from 1 to 4 respectively [10]. Calculate the weight of knowledge nodes in the knowledge graph:

$$w = (1 - \varpi)C + \varpi \sum P(W_k) \tag{4}$$

In the formula, $(1 - \varpi)C$ represents that the current node is accessed by other nodes with its intermediate centrality value, that is, the knowledge node with higher intermediate centrality has higher access value; C represents the mediality centrality of different knowledge points. $P(W_k)$ is the proportion of the weight of knowledge node k in the weight of its brother nodes with the same direct precursor as k node. Therefore, the knowledge map of different students is established, and according to the map, bayesian inference network is used to recommend personalized resources for students. The bayesian network is transformed into a joint tree, and then the global consistency of the joint tree is achieved through message transfer between nodes, and

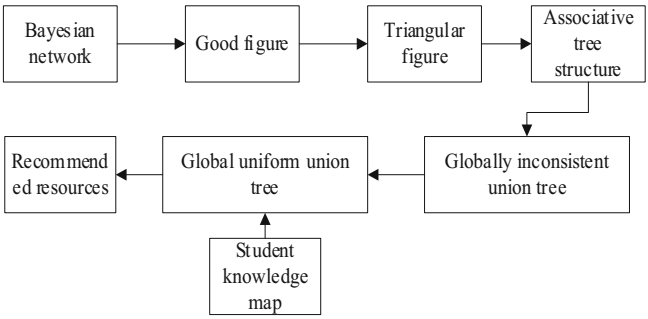

Fig. 3. Resource recommendation flow chart

then the probability calculation is carried out. Figure 3 shows the flow chart of learning resource recommendation.

In the process of teaching, students' knowledge graph is constantly updated and obviously differentiated. The process shown in the figure above can be used to recommend appropriate learning resources for students.

3.3 Auxiliary Teaching System Database Design

Whether the various functional modules of the teaching assistance system can be closely combined and how to combine hinge on whether the structure design of database is reasonable, especially the design of data table structure. Through the demand analysis of the teaching assistance system, and then guided by the principle of database, we get all the entities in the teaching assistance system, and each entity and its attributes belong to a basic table. The corresponding relationship table of some system entities is shown in Table 1.

Table 1. Correspondence table of some entities in the database of teaching assistance system

Field	The data type	Field size	Whether is empty	Key constraint
The teacher	Int	11	N	Primary key
The name	varchar	58	Y	–
Password	varchar	64	Y	–
Student student id	varchar	20	N	Primary key
The student's name	varchar	58	Y	–
Grade	int	11	Y	–
The class	int	11	Y	–
Teaching text resources	Longtext	200	Y	–

(*continued*)

Table 1. (*continued*)

Field	The data type	Field size	Whether is empty	Key constraint
Teaching video resources	varchar	150	Y	–
Teaching picture resources	char	180	Y	–
Teaching evaluation	Longtext	300	Y	–

When using the database to operate the data in it, it is inevitable to encounter performance problems such as access efficiency. Especially when the amount of data information is large, some unnecessary or unreasonable additional operations are likely to lead to the collapse of the database system and even the application. When the MySQL database accesses the table, the life cycle of "query" is roughly from the client to the server, then parse and execute the task on the server, and finally return the execution result. The stage of executing the task includes not only the call of retrieving data to the storage engine, but also data processing such as sorting and grouping. These calls need to operate memory and CPU, and may also produce certain context switching, so they are the core of the "query" life cycle and a waste of time. In order to avoid the participation of irrelevant data when accessing data, it is required to optimize at the code level and database design level. On the premise of meeting the needs of users, find out the bottleneck of the system and improve the overall performance of MySQL system services. Since the database used in this teaching assistant system is MySQL and the stored data are common, some common methods such as selecting reasonable field attributes, using foreign keys and indexes, optimizing query statements and so on are used to optimize data access.

The above software design content provides personalized and intelligent auxiliary functions for CAI system. Put the teaching assistant software function designed above in the hardware running environment, that is to complete the design of intelligent computer-aided teaching system based on cloud computing.

4 System Performance Test

After the completion of system development, the system needs to be tested to realize the quality assurance of software. This project will test the system from two aspects: function test and performance test. By constructing test cases and adopting appropriate test tools, the correctness of software functions is verified, and the problems existing in the system are detected and found to ensure the normal delivery of software. The whole CAI system includes several functional modules. In order to confirm that the CAI system can be used in actual teaching activities, its function can meet the daily teaching needs. In order to improve the persuasiveness of the experimental results, the experimental environment of the control group and the experimental group was consistent.

4.1 Experimental Content

Choose the traditional teaching assistant system to compare with this system. Firstly, the logic unit of the software is tested separately to test the correctness of the function of the logic unit of the system; Integration testing is to integrate the logical units of the system through the interface and test the problems existing in the integration between functional modules. When users use the system, if the response time of the system is too long, it will cause a poor use experience. Generally, the tolerance of system users to the response time of the system is within 5 s. The speed of teaching has a great impact on the normal teaching process. Therefore, the system uses response time to test the performance of the system. The performance of the system is evaluated by simulating the number of users of different orders of magnitude and accessing the system concurrently. Then carry out the function black box test of the system: according to the system function test case, check whether the program can receive data and produce correct output information, and maintain the integrity of the database or file. Determine test cases and infer the correctness of test results according to the program functional requirements specification. Black box test is to test whether the system function operates correctly on the basis of knowing the function of the system.

4.2 Experimental Result

Figure 4 shows the changes of students' academic performance after the two teaching assistant systems are applied to teaching activities.

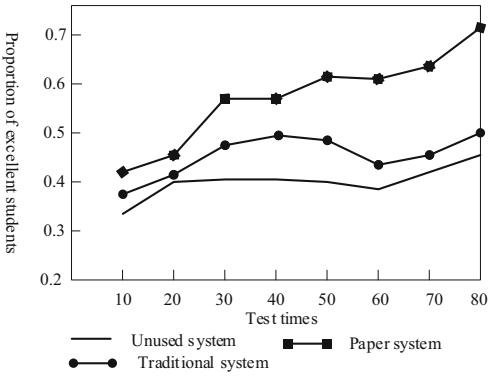

Fig. 4. Comparison of application of teaching assistance effect

It can be seen from Fig. 4 that after the application of the teaching assistant system, the students' scores are improved to a certain extent, but the students who apply the system in this paper have better academic scores, that is, the practical application effect of the system in this paper is better.

Table 2 shows the comparison of the response time of the two teaching assistant systems.

Table 2. Comparison of response time of teaching assistant system

Concurrent visits	Paper system			Traditional system		
	Minimum system response time/ms	Average system response time/ms	Maximum system response time/ms	Minimum system response time/ms	Average system response time/ms	Maximum system response time/ms
1000	106	118	112	128	168	148
2500	121	134	127	185	234	206
5000	154	162	143	236	287	260
10000	189	203	158	287	345	316
15000	233	257	174	369	402	374
20000	267	289	189	452	536	494
25000	293	335	205	491	588	538
50000	364	390	216	624	673	643

According to the test results, it can be seen that the system in this paper can still maintain a good response time without increasing the concurrent access of the system. Compared with the traditional teaching system, the response time of the teaching assistant system designed in this paper is shorter, which shows that the response rate of the system designed in this paper is faster. Numerically, the response time of this system is shortened by about 1/2, which can meet the auxiliary function requirements of teaching activities under the condition of high concurrency.

Summarizing the above system performance test data analysis, it can be seen that the intelligent CAI System Based on cloud computing designed in this paper has a high response rate and can meet the functional response under the condition of high concurrency. Compared with the traditional teaching assistant system, the application of this system in teaching can greatly improve the students' academic performance and their learning enthusiasm, which has high practical application value.

5 Conclusion

The development of information technology is also making profound changes in the field of education, providing a new stage for modern education, and promoting a new great leap in educational technology, educational system and teaching model. Computer aided education is an important embodiment of the application of electronic information technology in education. The computer does promote the teaching reform, improve the quality of teaching, lighten the burden of teachers and improve the ability of students. Cloud computing has infiltrated into all fields of today's society. A number of colleges and universities have joined the program abroad, and cloud computing has entered the category of education research in China. Considering the current teaching environment and social background for the continuous improvement of the demand for teaching assistant technology means, in order to properly handle the perfect application of computer

aided instruction system in the future teaching reform, this paper studies and designs an intelligent computer aided instruction system based on cloud computing.

For the next step of work, can increase the tutorial guidance module, the module can control the students' learning situation, grasp the students' learning level and make timely feedback, determine the next step of teaching content and should adopt the teaching methods, strategies, different levels of students with different methods, to make the students master the learning initiative.

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