Design of distance learning process monitoring system based on 5G communication network

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Abstract: In view of the low stability of the conventional monitoring system, a remote learning process monitoring system based on 5G communication network is designed. Analyze the requirements of monitoring system, optimize flash memory circuit, select dts6677 data concentrator, use 5G communication network to transmit monitoring data and instruction information, use sigmoid function to calculate the error between expected value and output value, optimize function module, and realize the design of remote learning process monitoring system under 5G communication network. The simulation experiment tests the performance of the system. The test results show that applying 5G communication network to the design of the remote learning process monitoring system can effectively improve the stability of the monitoring system and optimize the system performance.

Keywords:5G communication network; remote learning; monitoring system

1 Introduction

5G mobile network is the same as the early 2G, 3G and 4G mobile networks. 5G network is a digital cellular network. In this kind of network, the service areas covered by suppliers are divided into many small geographic areas called cellular. Analog signals representing sound and image are digitized in mobile phones, converted by analog-to-digital converters and transmitted as bitstreams. The main advantage of 5G network is that the data transmission rate is much higher than the previous cellular network, up to 10Gbit / s, faster than the current wired Internet, and 100 times faster than the previous 4G LTE cellular network [1]. Another advantage is lower network latency, less than 1 millisecond, compared to 30-70 milliseconds for 4G. 5G's performance objectives are high data rate, reduced latency, energy saving, cost reduction, increased system capacity and large-scale device connectivity. The first phase of the 5G specification in release-15 was to accommodate early commercial deployments. The second phase of release-16 will be completed in April 2020 and submitted to ITU as a candidate for imt-2020 technology. ITU imt-2020 requires a speed of up to 20 Gbit / s, which

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can realize wide channel bandwidth and large capacity MIMO. The monitoring system of distance learning process is designed by 5G communication network.

2 System design analysis

In distance learning, if the whole process of teaching is controlled by students, only a few learners with rich knowledge and experience can achieve good learning results. For most learners, self-control of learning pace, the number and difficulty of exercises often lead to disappointing results. So if the initiative of control is transferred from computer to learners, the interaction control will be unbalanced, which will eventually lead to the disappearance of real interaction. Therefore, learning monitoring mechanism should be introduced in the design of network courses to seek a balance between learners and computers, and give full play to the teaching interaction function of network resources to maximize learning. Psychological research shows that learning process self-control can be divided into two categories: monitoring component and control component [2]. The former is the conscious evaluation of the learning state being experienced, while the latter is the domination and domination of their own learning process. Learning control is based on monitoring, consciously choosing learning methods and actively adjusting learning process. In distance learning, the monitoring and control of learning process interact and both are in dynamic process.

In the design process of learning behavior monitoring system, "monitoring the learning behavior of learners" is the core, so we should make clear which learning behaviors of students should be monitored, whether the behaviors are effective, whether they have an impact on the learning results of students, and the results of these learning behaviors should be quantifiable and measurable, and consider how to collect these learning behaviors, what technical route to adopt, and whether the acquired behaviors are real and effective. After obtaining these behavior data, statistical analysis shall be carried out. Through in-depth analysis and mining of online learning behavior data, find out the internal relationship between online learning behavior and learning effect, and realize the formative assessment of distance learners. This fundamentally solves the problem that teachers evaluate students by subjective experience in the network teaching environment, so as to truly evaluate students objectively, fairly and fairly. This system starts from the monitoring of learning behavior to monitor learning behavior, but monitoring and evaluation are inseparable, so "monitoring and evaluation" work together to promote learners' learning [3]. The remote learning process monitoring system designed by us introduces the monitoring, feedback, evaluation and interaction mechanism designed by human, and has the functions of recording learners' learning situation, timely feedback learning effect and perfect communication mechanism. The system involves the following core issues: first, establish a perfect learning behavior database,

track the learning process of learners, and collect the data related to learning behavior in this process. Whether the data collection is complete, correct and effective affects the effectiveness of monitoring and evaluation to a great extent. Therefore, behavior data collection must ensure the comprehensiveness and accuracy of data collection. The second is to use a stable technical route to scientifically collect, sort, extract, process and analyze the data in the learning behavior database, and provide a visual operation interface to realize the real-time statistical analysis of students' online learning behavior. The third is to find out the relationship between learning behavior and learning effect according to the collected historical data of learning behavior and the learning achievements that students have achieved, and to carry out formative assessment on learners to achieve personalized learning support services.

3 Hardware design of remote learning process monitoring system

According to the above analysis results, it is optimized on the basis of the original hardware structure.

3.1 Design of Flash Memory Circuit

Flash memory can keep data for a long time without current supply. It is a kind of non-volatile memory, which is fundamentally different from common memory[4]. The memory module is mainly composed of flash memory chip and FPGA minimum working system, and its circuit principle is as follows:

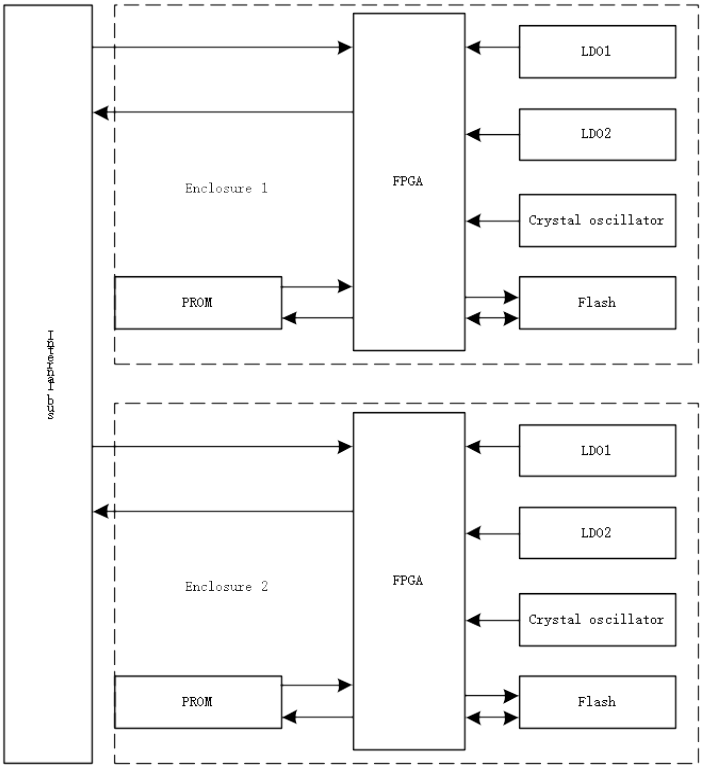

Fig.1. Schematic diagram of Flash memory circuit

As designed in Figure 1, the circuit part of the memory module is set as a dual backup system to improve its viability and reliability. Receive the data and instruction information through FPGA, write and erase flash according to the system command, and feed back the storage status to the standard acquisition module to ensure the normal operation of the system in the next step.

3.2 Design of signal acquisition and processing equipment

In the system hardware of the monitoring system, the signal acquisition equipment is the basic hardware to carry out the monitoring work. The hardware includes the signal concentrator, acquisition terminal and communication terminal, and the signal concentrator and acquisition terminal are distributed in different monitoring units. The two connect through the communication terminal to realize the transmission and reception of the monitoring signal. The signal concentrator connects the monitoring terminal, computer, communicator and sensor through the network signal, in addition, the collected signal is transmitted to the data monitoring and processing unit of the next stage, which has the functions of signal acquisition, instruction transmission, password communication and time recording. Therefore, the power

module, processing module, communication module and monitoring module are connected with them at the same time, that is, the signal concentrator becomes the data signal transmission and receiving hub of each system hardware [5]. In this design, the selected data concentrator model is dts6677 LCD, and its parameters are shown in the table below:

Table 1 Concentrator parameters

Scope of application	Communication monitoring, voltage monitoring, power distribution monitoring
major function	Receiving signal and command transmission
Accuracy grade	Active: level 0.25; reactive: Level 2
Communication protocol	DL/T645-2007
Reference voltage	3*100V
Reference current	3*1.5(6)A
Total power consumption	<1.5w，6VA
Outline size	265mm*170mm*75mm
Installation dimension	210(226)mm*150mm

The collection of power supply data in the monitoring system mainly depends on the circuit of ATT7022CU. The circuit uses a special power metering chip with high precision to measure various parameters and read and convert data through A/D converter. The collected data is displayed through the main display board of the touch screen. The model of the main display board selected here is V30U2417H, which is connected with the drive control chip, power switch, circuit switch, etc. So far, the optimization design of the hardware part of the system has been completed.

4 Software design of remote learning process monitoring system

With the support of the above hardware structure, the software part of the remote learning process monitoring system is designed by using the 5G communication network.

4.1 Overall functional optimization

In order to ensure the security of the system and the consistency of the data, the data storage layer is used to monitor the storage of the data, and the related data of the fault point is transferred to the processing layer. The monitoring results are docked with the data of other parts through the docking layer, as follows:

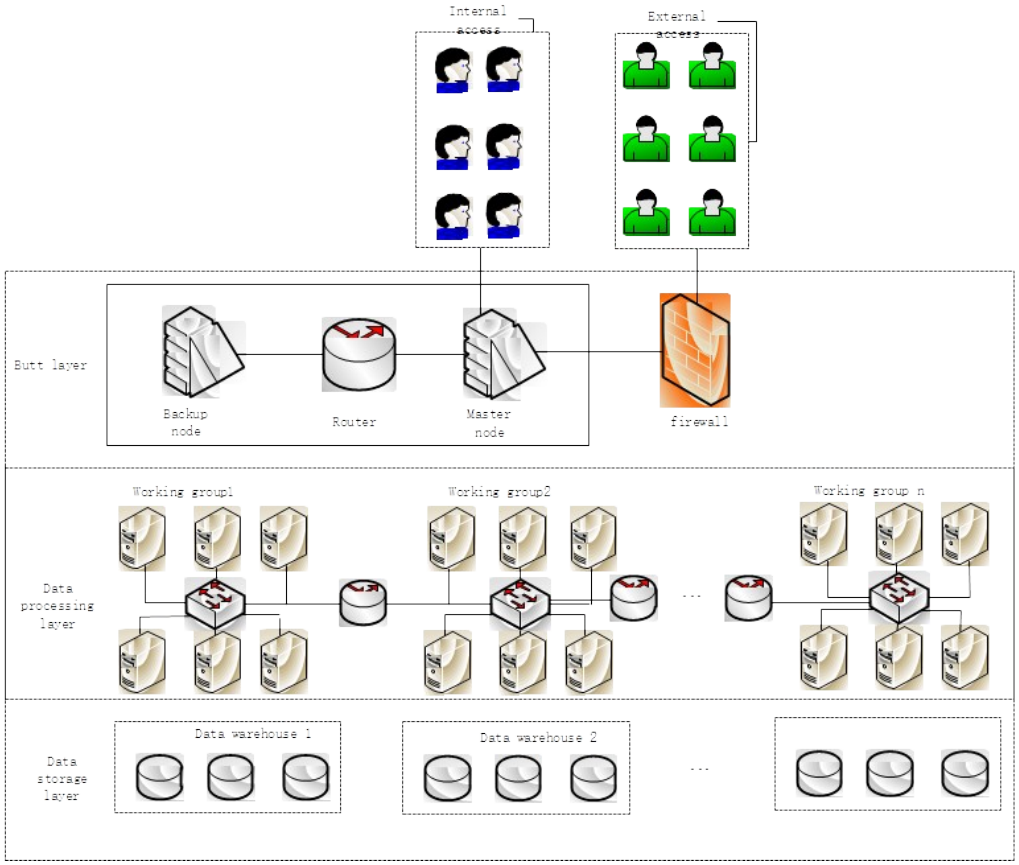

Fig.2. System Architecture

With the support of the above system architecture, the 5G communication network is applied to the monitoring system.

4.2 Optimization of Monitoring Signal Processing Based on 5G Communication Network

Processing the monitoring signal through each hidden layer, transmitted to the output layer, will not reach the expected value of the output value of the reverse transmission, after the output value is infinitely close to the expected value, the output of the monitoring signal is realized.

If the sample data set of the input layer is set to $\{(x_1, y_1),(x_2, y_2),...(x_a, y_a)\}$, its input data vector is:

$$x = \{x_1, x_2, ..., x_a\} \quad (1)$$

The input and output values of the hidden layer are calculated as follows:

$$\mathrm{Sigmoid}(x)=\frac{1}{1+h^{-x}} \qquad (2)$$

Among them, sigmoid function has the properties of single increase and inverse function single increase, which is used for the output of hidden neurons.

When the input value is x, the output value of the neural network is calculated as follows:

$$w_{er}^{i}(t+1)=w_{er}^{i}(t)+\Delta w_{er}^{i}(t) \qquad (3)$$

Where er represents the two nodes connected, i represents the number of layers where the value is located, w_{er}^{i} represents the weight of the i th layer, and $t=0$, Δw_{er}^{i} represents the weight modification.

At that time $r=1,2,...,n_{i-1}$, we got:

$$\Delta w_{er}^{i}=\mu x_{r}^{i} x_{e}^{i-1} \qquad (4)$$

Where, μ represents the learning step, and x represents the derivative of the error with respect to the weight.

The derivative value of the error of the output layer and the middle layer with respect to the weight is different, and the calculation process of the derivative value of the error of the output layer with respect to the weight is as follows:

$$\alpha_{r}^{i}=y_{r}(1-y_{r})(d_{r}-y_{r}) \qquad (5)$$

Where d_{r} represents the expected output value, and $r=1,2,...,a$, $y=[y_1,y_2,...,y_a]^{t}$.

Through the above calculation, the error between the expected value and the output value can be obtained, and the relationship between the learning step and the convergence rate can be found. So far, the processing optimization of monitoring signal based on 5G communication network is completed, and the system function module is designed on this basis.

4.3 Functional Module Design

The system has the following function modules: (1) course learning. Browse the learning course content according to the chapter directory of the course. The system sets record points

based on sections. After each section, the learner selects "complete learning" to record the learning time, learning path and other information[6]. (2) Class notes. This module is similar to the learning notes in traditional classroom learning. Learners can sort out and record the key points and difficulties in the learning process at any time, learning resource information related to knowledge points, or understanding of a knowledge point, etc. The system stores the learning note information in the database one by one, and each record is associated with the corresponding chapter, which is convenient for the learners to consult later. (3) Course interaction. Provide a public discussion area for all learners to discuss topics related to the course content, express problems or opinions, such as different understanding of a difficult knowledge point or the application of learning methods and learning strategies of the course. (4) Online exam. After learning a certain chapter, learners can take an online test to test their learning effect. The online test module supports the online test of learners. After submitting the test paper, the system can automatically score, give the test results, and record the results of each test [7]. The specific situation of its function module is as follows:

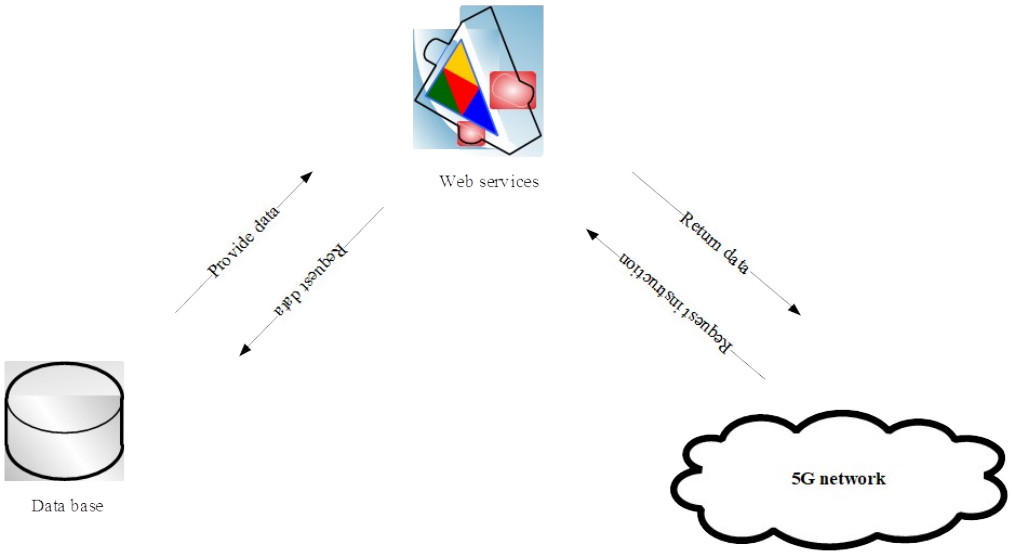

Fig.3. Architecture diagram

After logging in as a teacher, there are two functional modules: information management and user management. The function modules of information management are as follows: (1) Chapter management. This module realizes the organization, editing and modification of online course content by teachers. The content of online courses is pre selected by teachers. After logging in the system, online editing is carried out based on chapters or sections to add, delete or modify the text and picture content of courses. (2) Course introduction. It is used to

describe the relevant information of the online course, such as the introduction of course content, relevant teaching materials, teachers and learning methods. (3) Class notes. Teachers can view learners' learning notes. Learners can find and display the information recorded in the learning notes module here. Input the student number of the learner to be viewed, then the information of the learner's learning notes can be displayed in the form of a directory, with the title and time of each learning note written by the learner as the directory order, and the specific learning note content can be viewed. By checking the learning notes, the teacher can get a general understanding of the learners' understanding of the course content and some questions in the learning process, so as to give appropriate guidance and help [8]. To some extent, the content and time record of learning notes reflect the learners' emotion, attitude, method and other information of learning the course, which is also the reference for teachers to master the learners' learning situation. (4) Course interaction. Teachers can check the opinions and opinions expressed by learners here. By looking at the topics discussed between learners, teachers can understand the overall mastery of the course content and find out the problems, such as which questions are common problems, which need to be guided as a whole, which questions are the problems of individual learners, which need to be guided individually, etc. Similarly, this module provides a reference for teachers to understand the learners' feelings, attitudes, methods and other information of learning the course. (5) Online exam. This module supports teachers to organize online examination questions, check the examination situation of learners, etc. The test results of learners after learning a chapter are the important basis for teachers to master the learning effect of learners. Teachers can edit the test questions of each chapter online, check the test situation of learners, and adjust the difficulty of the test questions in time according to the test results, so as to obtain better learning effect. (6) Study time. In this module, teachers can query the learning time of each chapter. Enter the student ID of the learner to be viewed to display the time that the learner has completed each chapter and the time spent completing each chapter in a list. The learning time function module is the core module of the whole learning monitoring system and the main basis for monitoring learners' learning activities [9]. Through this module, teachers can understand whether the allocation of learning time is reasonable. Combined with the online examination and curriculum interaction of learners, teachers can objectively reflect whether the learning behavior of learners conforms to the learning law, how the learning efficiency and learning effect are, and what aspects should be given guidance and help.

User management module includes two parts: learner management and administrator management: (1) learner management. Used to find, add, modify or delete the learner account information. The login account of learners in the learning monitoring system is preset by the

teacher, that is, only the designated learners can log in to use the learning system, and other learners can't log in by themselves or wait for the approval of the administrator after registration, so as to avoid the use of irrelevant personnel at will, display a large number of useless data information, and disturb the monitoring management of teachers[10]. (2) Administrator management. It is used by teachers to manage their administrator identity. You can also find, add, modify or delete administrator account information[11]. When there are teachers and teaching assistants or multiple teaching teachers in a course, you can set administrator authority in this module.

5 System Function Testing

In order to verify the performance of the above system, a control experiment is proposed to simulate the running process of the designed system and get the test results.

5.1Preparation process

The operating system of the simulation experimental computer is windows 2018 or Windows XP, 8g memory, hard disk of 500GB or more, tms320c6678 debugging version, 5V, 3A DC stabilized power supply is used for the hardware. The relay is used to control the power of the equipment in operation state, so as to ensure that the CPU power of the monitoring equipment is kept between 50W and 80W.

With the support of 40s68s37n03 chip shown in Figure 4, eight external charging posts are connected with Arduino single chip microcomputer, ieee802.15 data transmission module, ARM processor and CC2530 device in sequence. Each of the two posts corresponds to one system element, which is connected from top to bottom, left to right. C18, R11, C8 and U5 are four same directional device control switches, among which C18 and R11 switch directly control the connection and closing state of 40s68s37n03 chip, C8 and U5 are connected with external resistance, and whether the resistance is connected to the circuit is controlled by the same connection or closing state.

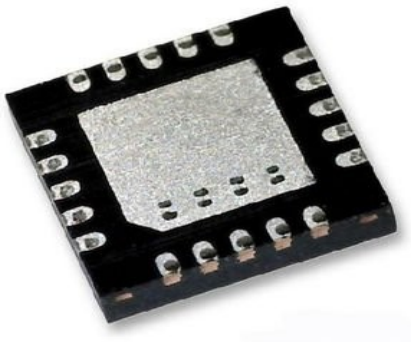

Fig.4 Smart controller monitor circuit charging chip

Under the premise of ensuring the normal operation of the 40S68S37N03 chip, the C18, R11, C8, U5 switch is closed at the same time, and the external resistor is directly connected to the charging circuit, the experimental detection of the monitoring effect of the remote learning process under the 5G communication network is started.

5.2 Interpretation of result

The long-distance learning process monitoring system and conventional monitoring system under 5G communication network are respectively connected with the experimental acquisition device, which are the experimental group and the control group. Adjust the relay several times to control the electric power between 65W and 70W, and ensure the operation frequency of the monitor between 35Hz and 50Hz. After each experimental monitoring operation, the equipment is allowed to stand for 2 minutes to ensure the reliability of the test results. Seven connection ports of the optical access network are selected for four experiments, and the following data results are obtained.

Table 2. Test results of experimental group

Port	1	2	3	4
A1	0.96	0.95	0.95	0.96
A2	0.94	0.95	0.94	0.95
A3	0.95	0.96	0.94	0.95
A4	0.94	0.95	0.96	0.94
A5	0.97	0.94	0.95	0.95
A6	0.94	0.94	0.96	0.94
A7	0.95	0.95	0.95	0.94

Table 3. Test results of control group

Port	1	2	3	4
A1	0.91	0.85	0.84	0.88
A2	0.89	0.87	0.9	0.85
A3	0.9	0.91	0.88	0.85
A4	0.91	0.91	0.89	0.87
A5	0.85	0.83	0.87	0.85
A6	0.88	0.84	0.9	0.91
A7	0.9	0.85	0.87	0.88

Comparing the above two groups of results, under the premise of stable electric frequency voltage, the stability of the designed automatic monitoring system's received signal

reaches 0.94, and the maximum value reaches 0.97, the average stability result is 94.89%; while in the control group's four experiments, the signal reception stability fluctuates greatly, the maximum value is 0.91, the minimum value is 0.83, and the average stability test result is 87.64%. In contrast, the stability of the designed automatic monitoring system is 7.25% higher than that of the conventional monitoring system. It can be seen that the designed system is more stable and more in line with the actual monitoring requirements.

6 Conclusion

5G communication network is applied to the remote learning process monitoring system to provide users with better service and better user experience.

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