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Research Article

Design and Optimization of Children's Education Online Monitoring System Based on 5G and Internet of Things

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At present, the problem of children's education informationization is becoming more and more prominent. With the strengthening of national education, children's online education has become one of the main forms. In order to educate children online, this paper proposes an online education system based on 5G technology and Internet of Things technology, which mainly solves the problems existing in current education. The results show the following: (1) UI test results basically meet the requirements of users; for the pursuit of personalized users, further development and improvement are needed. (2) Compared with children's module, the response time of manager module increased by 12%, and all the response times did not exceed 10s, so the user experience was very good. The access success rate of children's module is 99%, and that of managers' module is 98%. It is necessary to further study what factors interfere with the success rate, which leads to the failure of 100% success. (3) After optimization, the total energy consumption is the lowest compared with NOMA and TDMA, which is the best energy efficiency optimization method to solve the communication of Internet of Things. The simulation of the system is in good condition, and the follow-up research work of developers will take this system as the core to improve more details, hoping to put it into market operation formally.

1. Introduction

Children's education has always been the focus of education departments and industries. China's online education industry has experienced more than 20 years of development, which is closely related to modern information technology. However, the online education content for children's education is uneven, which brings about many worries and worries school parents. Relevant state departments and parents need a high-quality online monitoring system to monitor. As we all know, children's education is a key topic that even the whole world pays attention to. It is a very effective way to improve the national quality to carry out high-quality education for children in a country. Young children's brains are not fully developed when they are growing up. At this time, if the relevant state departments and parents do not give good guidance, coupled with the impact of the online world, they will miss the best time to educate children. Compared with younger children, older children are easily affected by electronic devices. At this time, if there is no effective system to monitor, educate, and standardize children's behavior online, children will probably be exposed to bad information in advance or accept negative influences from society. These two situations will be disastrous and devastating to children's development and growth. Therefore, this paper carries out the research on online monitoring of children's education in order to get an excellent system that can guarantee children's safety and education quality and help schools and families reduce their burdens. The literature [1] survey considers the Internet to be a tool to support schools and provide children with opportunities for informal learning, literacy, communication, and participation. Literature [2] uses Internet to educate teenagers about osteoporosis. Literature [3] identifies a series of potential daily concepts to educate children on network security in the early stage of Internet. Literature [4] develops a game system connected to the Internet of Things platform to record children's game activities for fine stimulation of children aged five to six years. Literature [5] developed and tested an early counseling system for children with developmental disorders by using the Internet. Literature [6] shows how children between the ages of nine and twelve years use different models to describe the Internet and talk about reliability. Literature [7] implements the practice and management system of "children's science education" by using remote Internet video conference. Literature [8] systematizes children's ecological and art education under the background of national cultural tradition through teaching modeling method and establishes a consistent theoretical basis. Literature [9] discusses children's education in a safe guardianship environment, hoping to achieve a global understanding of effective policies and practices. Literature [10] discusses exploring ways to promote the integrated development of children's technical thinking and humanistic thinking, virtual thinking and realistic thinking, and divergent thinking and convergent thinking in the era of "Internet plus." Literature [11] carries out systematic robot education for children through cooperative and robot-based learning. Literature [12] studies the QoE-aware resource allocation mode provided by 5G tactile industrial Internet of Things, which is applied to medical care, manufacturing, mining, education, automatic driving, and other fields. Literature [13] investigates various optimization methods to solve the resource problems of 5G and Internet of Things from the technical level. Literature [14] proposes key technologies for applying MEC to 5G and Internet of Things, such as cloud computing, network function virtualization, information-centric network, intelligent devices, network slicing, and computing offload. Literature [15] studies the Internet of Things intelligence and 5G network to establish sports and health big data system to solve some open problems. Better promoting the digital and intelligent transformation of education industry can better promote the rapid development of online education, meet the increasing needs of people, and help schools and families reduce their burdens. Establishing a system can be conveniently used by parents, teachers, and children. Through the division of labor and cooperation between the manager module and the children module, the educational content suitable for children can be screened and avoided from the source, and the physical condition, positioning, and social interaction of children can also be supervised, which is convenient for parents and teachers to find children's problems as soon as possible and sort out and guide them in time. In order to build a modern online monitoring system suitable for children's education, according to the capital cost and various needs of children's education, we choose to link the Internet of Things with distributed systems and use Java as a programming language to realize a distributed architecture system based on 5G Internet of Things communication.

2. Theoretical Basis

2.1. 5G Technology. In recent years, new high-quality technologies have emerged continuously, rising in many computer network fields, which not only changes people but also facilitates people's lives and habits. Mobile communication technology has been developing from 1G, 2G, 3G, and 4G. After years of development, it has continuously broken through the technical constraints and now successfully developed into the fifth-generation mobile communication technology. We usually simplify this name to 5G technology [16], which all comes from a simple formula [17].

$$c_{(\text{speed})} = \lambda_{(\text{wavelength})} \nu_{(\text{frequency})}. \tag{1}$$

Conduct 5G 28 GHz frequency band test according to international standards [18]:

$$\begin{aligned} \text{wavelength} &= \frac{\text{speed}}{\text{frequency}} \\ &= \frac{300,000,000\,\text{m/s}}{28,000,000,000\,\text{Hz}} \approx 10.7\,\text{mm}\,(\text{millimeter}). \end{aligned} \tag{2}$$

The method of communication technology to disseminate information and data [19] is shown in Figure 1.

It has powerful functions of more efficiency and convenience and lower delay than 4G, and it is also a powerful network infrastructure guarantee for us to realize the new era of interconnection among people, things, and machines (Internet of Everything). The coverage area comparison is shown in Figure 2.

5G technology will help researchers provide key technical knowledge in the fields of industry, education, medical care, unmanned driving, energy, and so forth, so that there can be newer technological breakthroughs in these fields, as shown in Figures 3 and 4.

2.2. Internet of Things Technology. Internet of Things (IoT) [20] is a new technology in the 21st century which can realize the Internet of Everything. It is an effective crossing and integration of virtual world and real world, and its development trend in China is good. With the development of time, it has gradually become an important symbol for China to enter the information age in an all-round way. Internet of Things (IoT) relies on sensors and other devices to collect information and then realizes the function of information exchange with the help of network (this paper chooses to use more efficient 5G network). The future ubiquitous network [21] is the embodiment of the Internet of Things at a higher level. Here, it is briefly mentioned that it is the prospect of the future direction of the Internet of Things. As shown in Table 1, it is the development standard table of Internet of Things technology [22].

Here, we explain the system framework of the Internet of Things as shown in Figure 5.

The Internet of Things architecture is divided into three layers: application layer, network layer, and

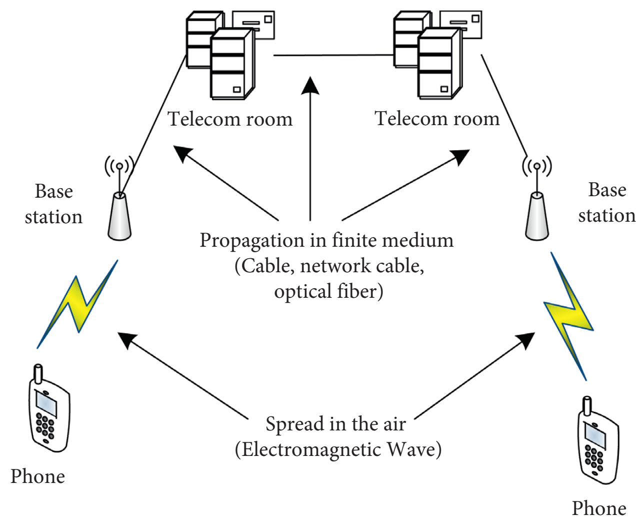

Figure 1: Communication technology propagation diagram.

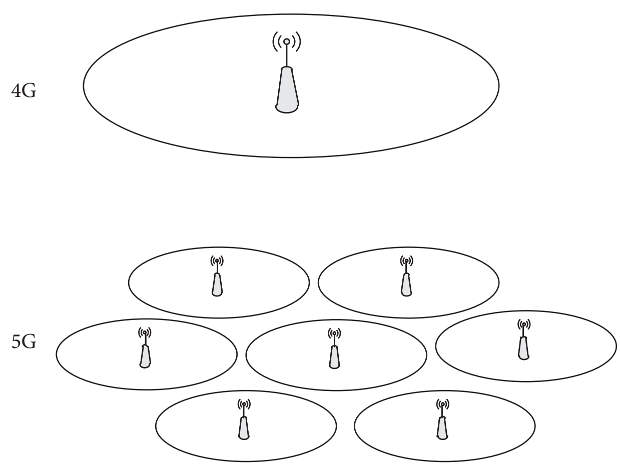

Figure 2: Comparison between 4G and 5G.

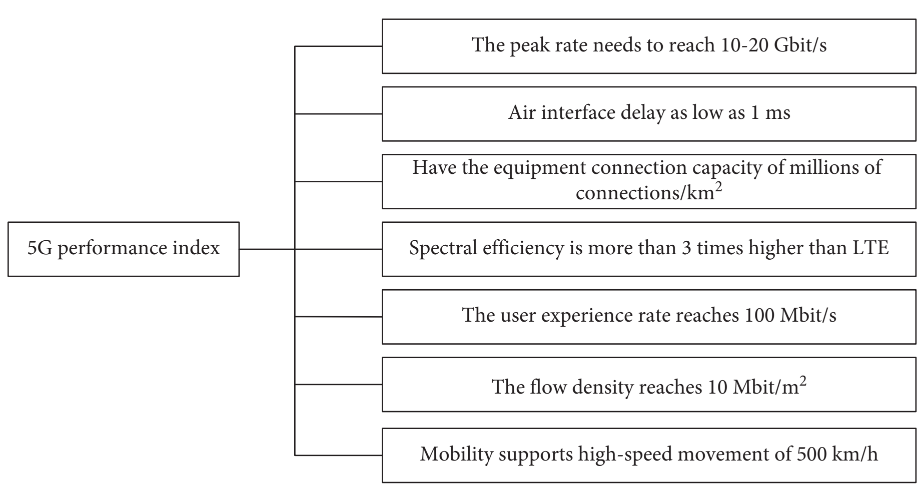

Figure 3: 5G performance indicators.

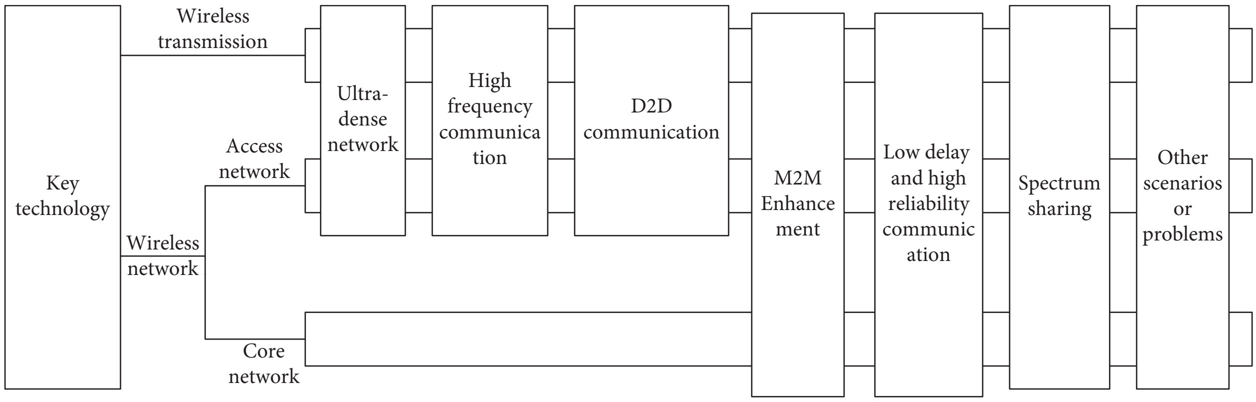

Figure 4: Overall framework of 5G key technologies.

Table 1: Standards and standards organizations.

Abbreviation	Full name	Standards being developed
Automatic identification laboratory	Automatic identification center	Networked Radio Frequency Identification and Emerging Sensing Technology
EPCglobal	Electronic product code technology	Standard using EPC (EPC coding) technology
FDA	US Food and Drug Administration	UDI (Unique Device Identification) system for different identifiers of medical devices
IEEE	Institute of Electrical and Electronics Engineers	Underlying communication technology standards, such as IEEE 802.15.4
IETF	Internet Engineering Working Group	Standards that include TCP/IP
OMA	Open Mobile Alliance	OMA DM and OMA LW2M for IoT device management, and GotAPI for IoT application security framework

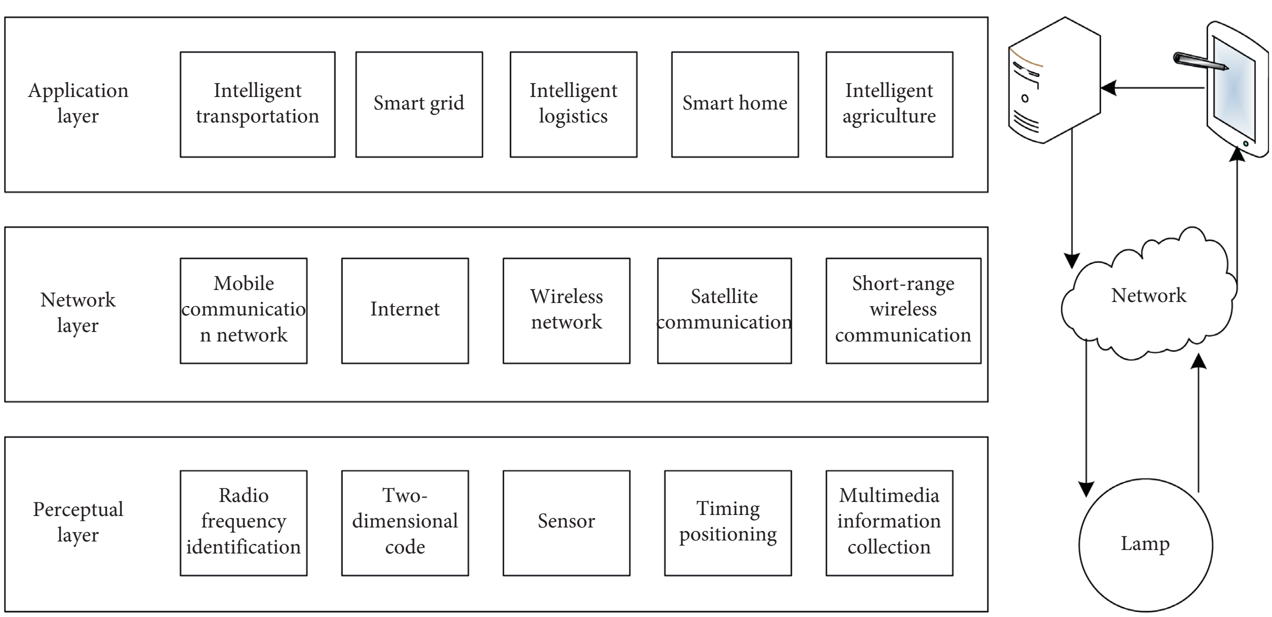

Figure 5: Schematic diagram of Internet of Things architecture.

perception layer. Perception layer is responsible for information collection and information transmission between objects. The network layer uses wireless and wired networks to encode, authenticate, and transmit the collected data. The mobile communication network is the infrastructure to realize the Internet of Things, forming a collaborative awareness network. The application layer provides specific applications and combines the Internet of Things technology with the needs of industry informationization.

2.3. Distributed Systems. In the early development of the system, there was a high demand for servers, the cost of software was very high, and it was very troublesome to expand and upgrade. Figure 6 shows a schematic diagram of the centralized system [23].

Therefore, due to the limitation of funds and core technologies, we choose a distributed system that simplifies the logical structure of the host and can be included in the scope of system use without highly configured computers. It is a multiprocessor computer system with independent hardware and unified software, which is easy to upgrade and expand, and its availability is often higher than that of centralized systems. Figure 7 shows a schematic diagram of the distributed system [24].

2.4. Children's Educational Concept. The ultimate goal of the concept of children's education is for children to grow up healthily and smoothly into the plastic talents of the country. Children are the flowers cultivated in the greenhouse of the motherland, and we should create a safe and reliable environment for children, which is isolated from all external dangers and suitable for seedlings to thrive. Here, children will be nourished by sunshine, rain, and fertilizer and can be well cultivated both materially and spiritually.

2.5. Research Methods. In this paper, we need to take some methods to collect and sort out the opinions and needs of schools, parents, and children, so as to understand what kind of effect our system should achieve, what functions it needs to have, and whether it can meet the real needs of schools, parents, and children. (1) Literature research method [25]: We selectively refer to many documents, not only Chinese documents but also foreign documents, and obtain materials from various academic websites such as China Academic Journal Network, Baidu Academic, and China Knowledge Network. After careful screening, these documents are the scientific theoretical basis of this study. (2) Questionnaire: We use questionnaires to distribute 1000 questionnaires to the relevant respondents (students, parents, and teachers) and collect 963 questionnaires. We use SPSS 19.0 to input and count the data (without showing). We can get the expectations and wishes of the respondents for the system from these questionnaires, and our design will be designed and improved based on their ideas. Only a system that meets the wishes of the demander is a qualified and good system.

3. Design and Optimization of the System

3.1. Design Objectives and Feasibility Analysis. The design goal of this study is to build a modern online monitoring system suitable for children's education. According to the capital cost and various needs of children's education, we choose to link the Internet of Things with distributed systems and use Java as a programming language to realize a distributed architecture system based on 5G Internet of Things communication.

(1) Economic feasibility. 5G and Internet of Things technologies are mature and are widely used in China. The related industrial chain is also relatively perfect, and the cost of application will not be too much. Because of its own characteristics, the distributed system has lower requirements for related computer configuration, which also saves a lot of money in disguise. So we say that this system is economically feasible.

(2) Technical feasibility. Internet technology is changing with the international trend, and its development is very mature, and it has been widely used in various fields. Therefore, this study is technically feasible and reliable.

(3) Feasibility of social environment. For schools and parents, it is the most difficult for a child with immature mind to judge his thinking. The complexity of society (especially on the Internet) is difficult for young children who have no independent thinking ability to cope with, and children are easily hurt. Therefore, for the social environment, it is necessary and feasible to design this system.

3.2. Architecture Design of the System. We choose Apache Mina technology for this system, and the system framework is shown in Figure 8.

Remote control uses ActiveMQ to transmit messages to instruction forwarding module, which is the consumer of messages. After receiving messages, it forwards them to the corresponding session and sends them to the equipment through this channel to realize bidirectional communication of data. Because the information security of a system is very important, especially in the education of children, the system needs to prevent the invasion of global criminals through malicious attacks, tampering, destruction, and so forth and strictly refuse any individual or computer that has not been accessed through formal channels. Figure 9 shows a schematic diagram about electronic security technology:

3.3. Functional Design of the System. The various functions of this system are carefully designed according to the results of the questionnaire, which are mainly divided into manager module and children module. The system covers children's humanistic education, safety education, thinking education, health education, and so on. Because of the particularity of this system, when visiting the system for the first time, the school or parents must log in, authenticate, and grant permission, and children can use the specific services of this system and will be guided and monitored by parents or teachers in the process of learning online.

3.3.1. Manager Module. The administrator module is mainly used by school teachers or parents, and the available functions are shown in Figure 10.

(1) The data information function is to give it to the system to determine whether it is qualified for

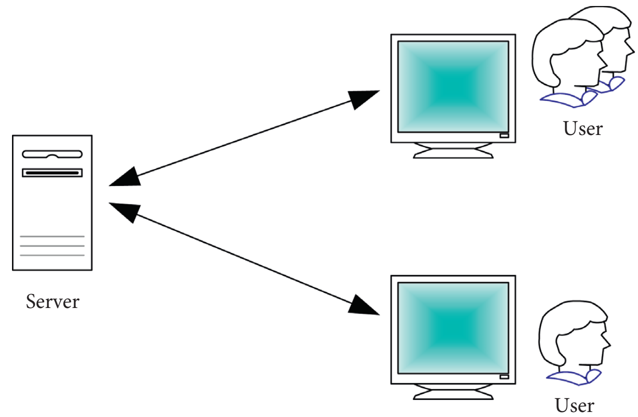

Figure 6: Centralized system.

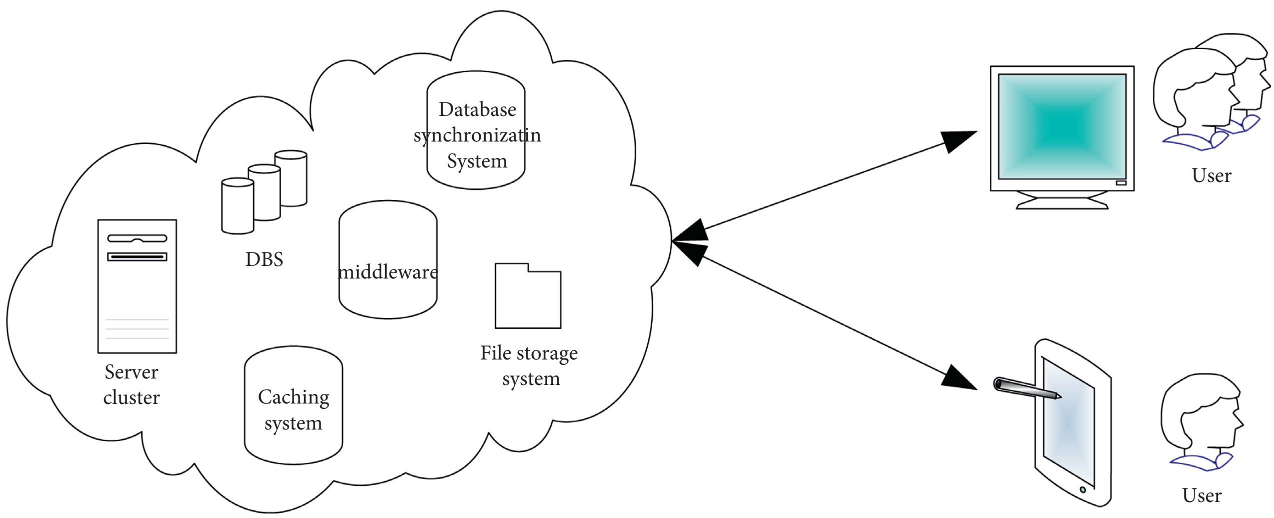

Figure 7: Distributed system.

identity authentication and register an account for children. The flow chart is shown in Figure 11.

(2) The child positioning system is to monitor the position of children and ensure that children are in a safe guardianship range. Figures 12 and 13 show an overall block diagram of positioning and a flow chart of positioning monitoring.

(3) The lock management function is set to prevent children from indulging in the online world and facilitate parents or teachers to manage. Children's equipment can be controlled by turning on or off this function directly in the system.

(4) The function of learning data status is to facilitate parents or teachers to monitor children's specific learning progress at any time, generate reports to parents or teachers at any time, *and adjust children's education programs at any time according to data results. The health*-related management function is to monitor children's health status at any time, generate reports to parents or teachers, and find and treat problems as soon as possible. The flow chart of obtaining the report is shown in Figure 14.

(5) Home/school equipment control is to facilitate parents or teachers to efficiently manage the equipment around children, as shown in Figure 15.

(6) The emergency function is to contact parents or teachers at any time if children are in any danger, and parents and teachers can make relevant treatment quickly.

(7) Feedback and opinions are to provide parents or teachers with reasonable feedback channels to help developers maintain, update, and optimize the system.

3.3.2. Children's Module. This module aims to help children receive various kinds of education, pay attention to the process of children's healthy development and happy growth, and give children a happy childhood experience. The specific functions are shown in Figure 16.

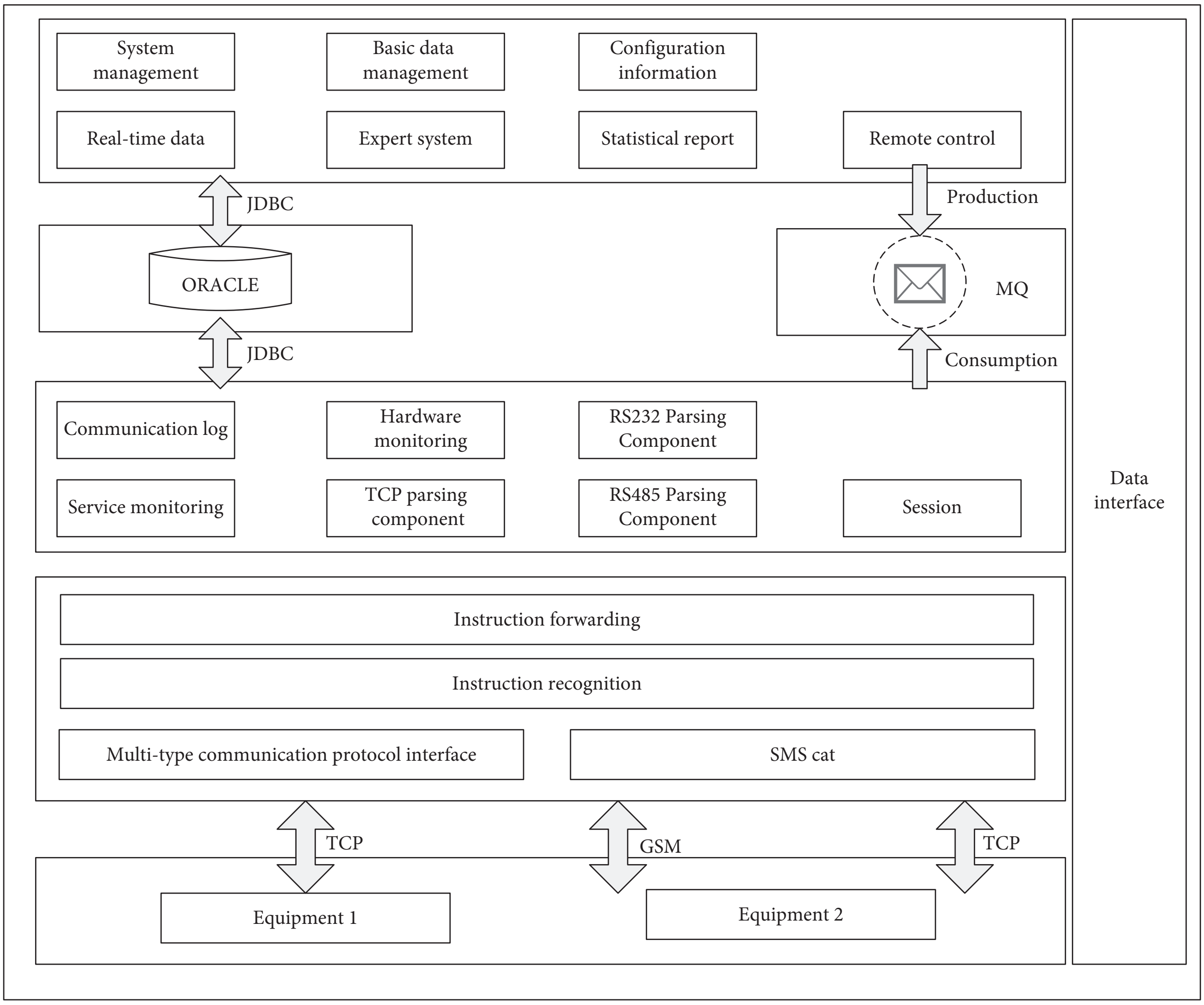

Figure 8: Distributed architecture of Internet of Things.

(1) Humanistic education is the education of basic simple subject knowledge. Art education is to cultivate children's hobbies, such as piano, painting, dance, and calligraphy. Traditional culture education is based on our national cultural characteristics, explaining our customs, etiquette, diet, and other contents. Traffic safety education is to popularize traffic signs, traffic rules, emergency calls, and so on. Network security education is to teach children how to surf the Internet safely and protect personal privacy. Health education is to teach children not to be picky eaters and learn to describe uncomfortable places, health knowledge, simple food nutrition and health, and so forth.

(2) Educational robot is an application layer device that can connect with children's system and share information. Children can use educational robots to learn directly, and robots will send relevant data back to children's systems, which is convenient for data recording.

(3) Puzzle games are designed for children, which are entertaining, so that children can learn useful knowledge imperceptibly while entertaining.

(4) Systems can be connected with each other, so that children of the same age can know each other and develop social skills.

(5) Child location monitoring is a passive function, and children cannot turn off this function directly. When the manager module makes positioning requirements, the system will automatically collect information and send it to the manager module.

(6) Physical condition data is a device worn by children, which is connected to the children's system to record the data.

(7) Emergency contact function is a function used by children in emergency or danger, which can immediately contact school teachers or parents and connect remote video calls.

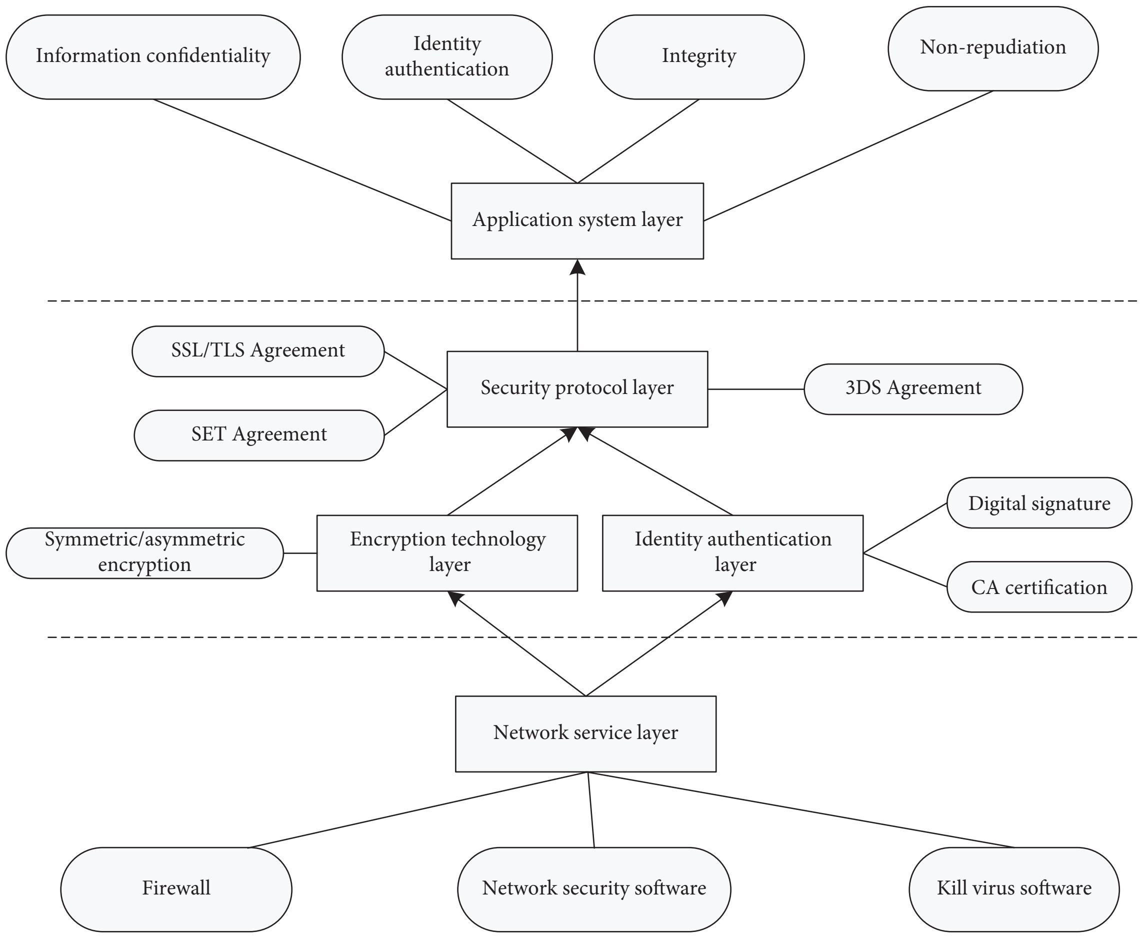

Figure 9: Electronic security technology.

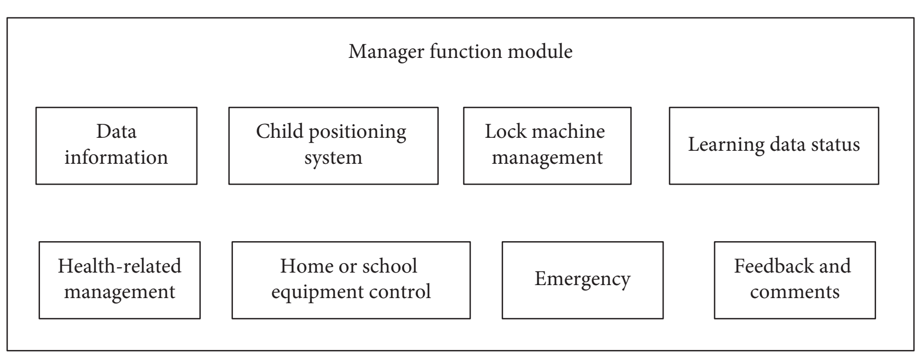

Figure 10: Introduction of manager module function.

3.4. Technical Optimization. When optimizing the system, we can use tools that can help locate system performance problems, but it should be noted that there are some system problems that cannot be detected by the tools, or we need to use other methods for optimization operations. The related tools are shown in Table 2.

3.4.1. Optimization of Code Quality. Efficient and excellent code usually has comments and code. The quality and logic of the code are very important, which can save developers unnecessary work and trouble. When doing some optimization work, we should carefully modify our code. In many cases, a little change can improve performance. Therefore, it is proposed that we should not optimize too early or over-optimize, for example, slow query caused by modifying SQL statements and frequent creation or replication of large objects.

3.4.2. Optimization of Internet of Things Communication. The optimization of energy efficiency is a very important issue. We will use a series of formulas for optimization.

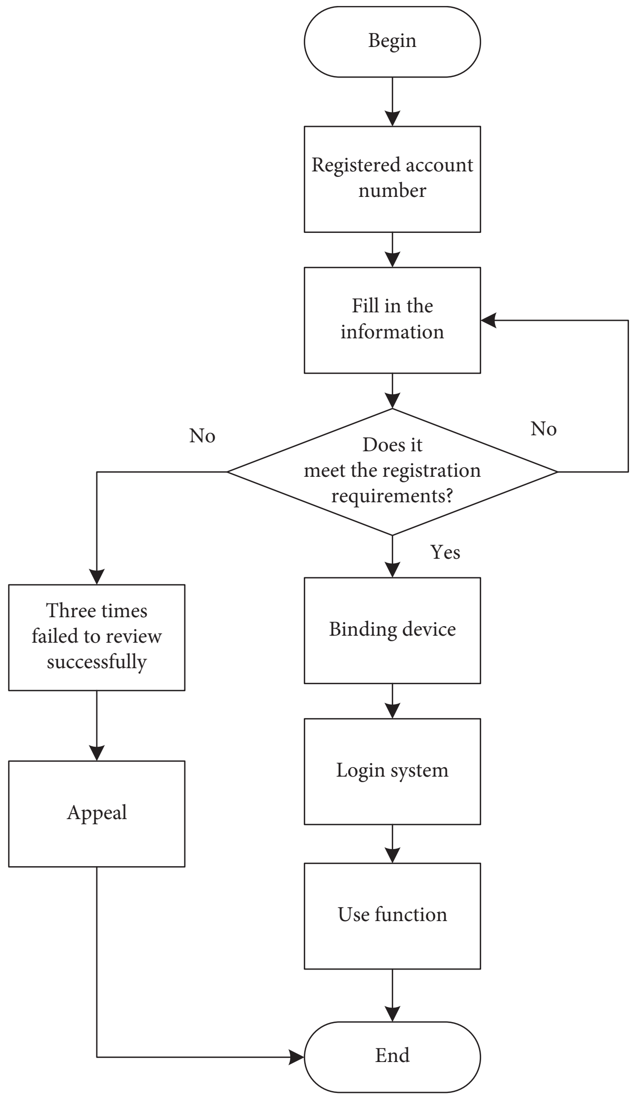

FIGURE 11: Flow chart of data information authentication.

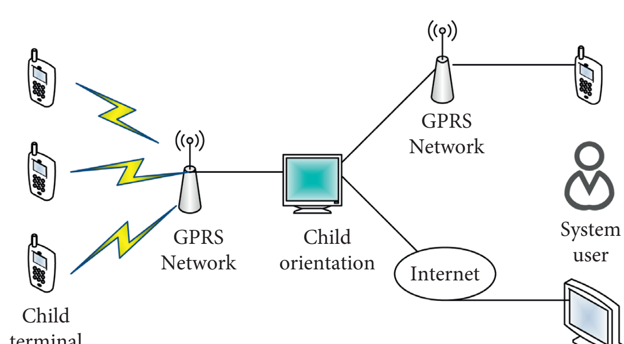

FIGURE 12: Child positioning system.

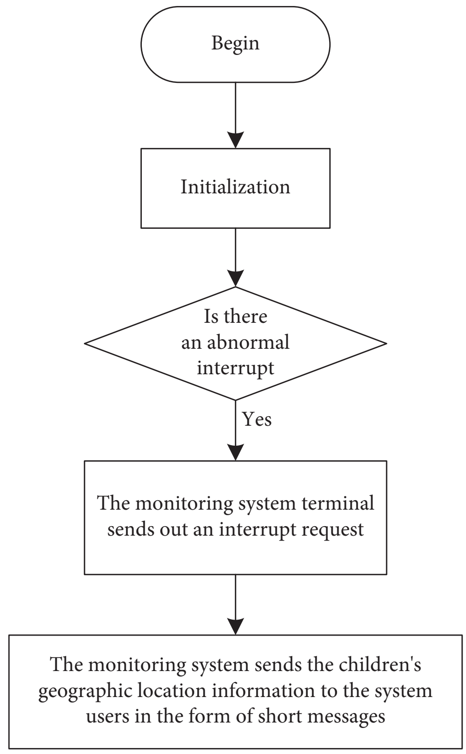

Figure 13: Flow chart of positioning monitoring.

(1) System model:

(1) The problem of SDN to UE:
The SDN is allocated to each UE, and the allocation factor A_{ij} is calculated.

$$A_{ij} = \frac{U_i}{d_{ij}}. \quad (3)$$

The transmission time meets the conditions:

$$\sum_{i=1}^{N} t_i \le T_i. \quad (4)$$

Received signal:

$$y_i = \sum_{j=J_{i-1}+1}^{J_i} h_{ij}\sqrt{p_j}s_j + n_i. \quad (5)$$

Achieve data throughput:

$$r_{ij} = Bt_i \log_2\left(1 + \frac{\left|h_{ij}\right|^2 p_j}{\sum_{l=j+1}^{J_i}\left|h_{ij}\right|^2 p_l + \sigma^2}\right). \quad (6)$$

Energy minimization problem from SDN_s to UEs:

$$\min_{p,t}\sum_{i=1}^{N} t_i \sum_{j=J_{i-1}+1}^{J_i} p_j. \quad (7)$$

(2) UE to base station problem:
Signal received by antenna:

$$y_l = \sum_{i=S_{l-1}+1}^{S_l} h_{li}\sqrt{q_i}m_i + n_i. \quad (8)$$

Achieve data throughput:

$$r_{il} = B_{SC}t_j \log_2\left(1 + \frac{\left|h_{li}\right|^2 q_i}{\sum_{k=i+1}^{S_l} q_k\left|h_{lk}\right|^2 + \sigma^2}\right). \quad (9)$$

UE_s to BS energy minimization problem:

$$\min_{Q,t}\sum_{j=N+1}^{N+L} t_j \sum_{i=S_{l-1}+1}^{S_i} q_i. \quad (10)$$

(2) Energy efficiency optimization:

(1) Optimization from SDN to UE:
Transmit power:

$$p_j = \frac{\sigma^2}{\left|h_{ij}\right|^2}\sum_{m=j}^{J_i}\prod_{k=m}^{J_i}\left(e^{(\ln 2)D_{j_i+j-k}/Bt_i - 1}\right). \quad (11)$$

Substituting formula (11) into (7) yields

$$\min_{t}\sum_{i=1}^{N}\sum_{j=J_{i-1}+1}^{J_i}\frac{\sigma^2 t_i}{\left|h_{ij}\right|^2}\sum_{m=j}^{J_i}\prod_{k=m}^{J_i}\left(e^{(\ln 2)D_{j_i+j-k}/Bt_i - 1}\right). \quad (12)$$

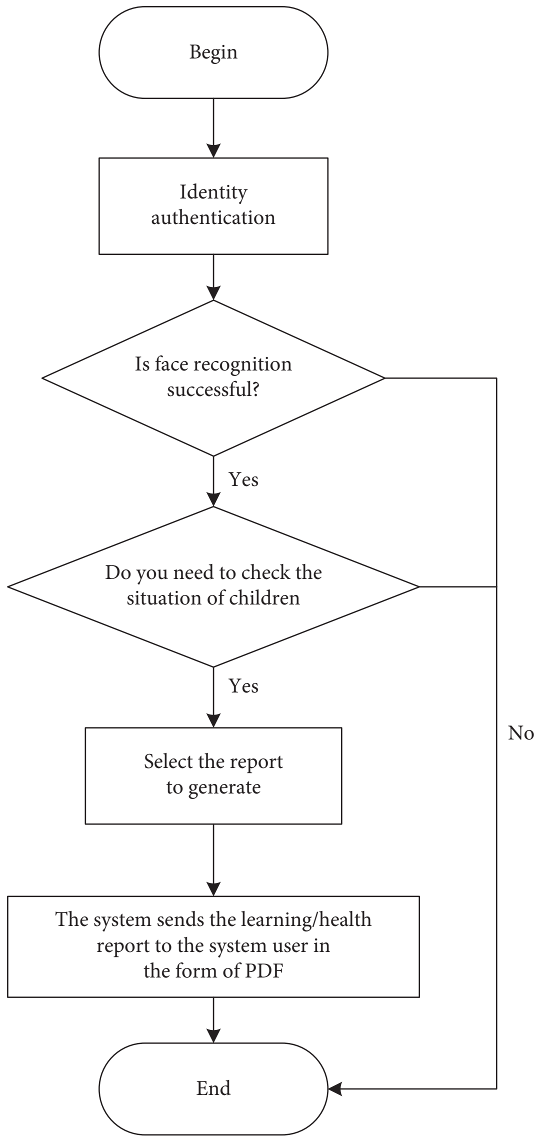

Figure 14: Learning and health report acquisition flow chart.

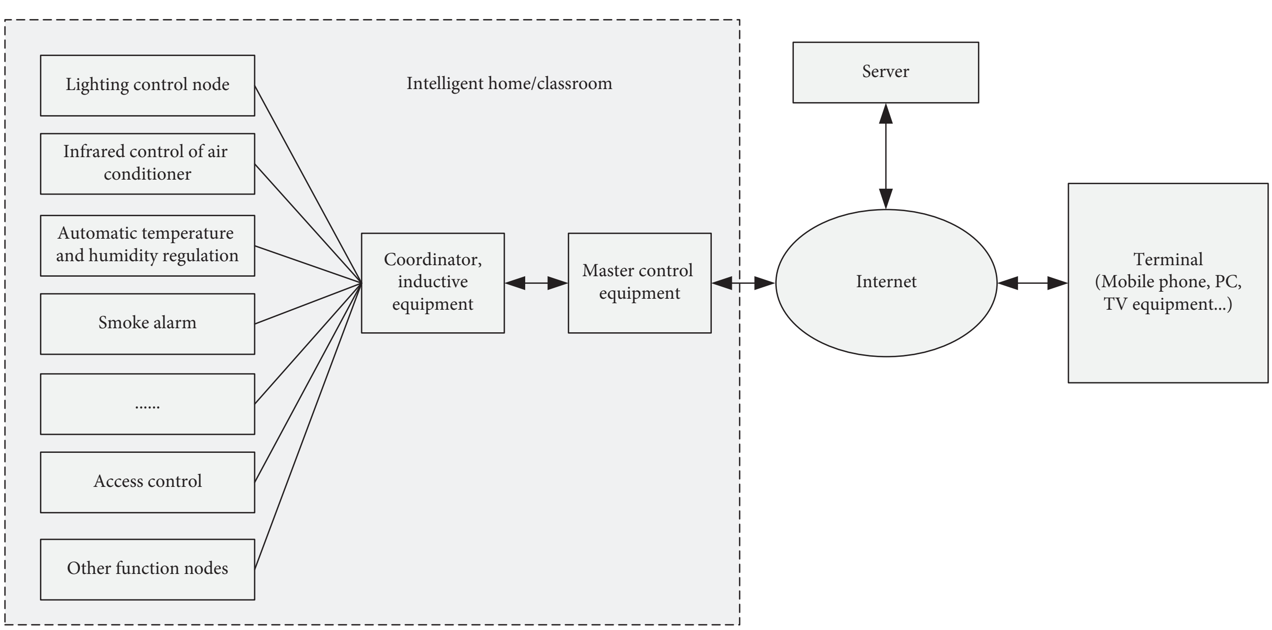

Figure 15: Equipment control structure diagram.

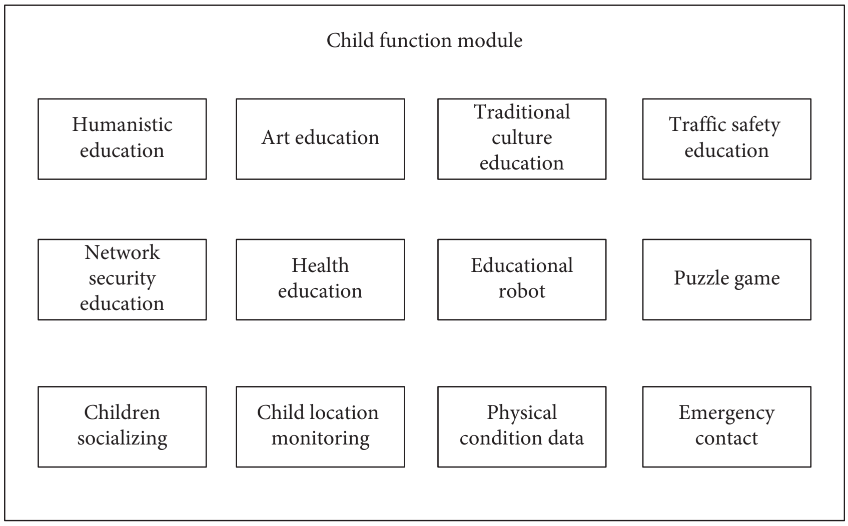

Figure 16: Introduction of children's module function.

Table 2: Tools for locating performance issues.

Type	Problem	Tools
Network	Network connection	Ping, netstat, traceroute, tcpdump
Disk	Read and write performance	IOTOP, IOSTAT
Memory	Memory leak	Valgrind, Purify
Memory	Memory swap	Free, top

Lagrange function:

$$L(t,\lambda) = \sum_{i=1}^{N} \sum_{j=J_{i-1}+1}^{J_i} \frac{\sigma^2 t_i}{\left|h_{ij}\right|^2} \sum_{m=j}^{J_i} \prod_{k=m}^{J_i} \left(e^{(\ln 2) D_{j_i+j-k}/Bt_i} \right) + \lambda \left(\sum_{i=1}^{N} t_i - T_1 \right). \quad (13)$$

The optimal solution should satisfy

$$\frac{\partial L}{\partial t_i} = 0. \quad (14)$$

(2) Optimization from UE to BS:

$$\min_t \sum_{l=1}^{L} \sum_{i=S_{l-1}+1}^{S_l} \frac{\sigma^2 t_l}{\left|h_{li}\right|^2} \sum_{m=i}^{S_l} \prod_{k=m}^{S_l} \left(e^{(\ln 2) E_{S_l+i-k}/Bsct_l - 1} \right). \quad (15)$$

3.4.3. *Distributed Optimization Algorithm*

(1) Distributed problem description:

$$\begin{cases} \min f(x) = \sum_{i=1}^{n} f_i(x_i), \\ \text{s.t. } x_1 = x_2 = \cdots = x_n. \end{cases} \quad (16)$$

Single integrator system:

$$\dot{x}_i = u_i. \quad (17)$$

(2) DGD continuous time form:

$$\dot{x}_i = -Lx - \alpha \nabla f(x). \quad (18)$$

(3) EXTRA continuous time form:

$$\begin{aligned} \dot{x} &= -Lx - \alpha \nabla f(x) + y, \\ \dot{y} &= -Lx. \end{aligned} \quad (19)$$

(4) Classical primal-dual algorithm:

Distributed problem description:

$$\begin{cases} \min f(x) = \sum_{i=1}^{n} f_i(x_i), \\ \text{s.t. } D^T x = 0. \end{cases} \quad (20)$$

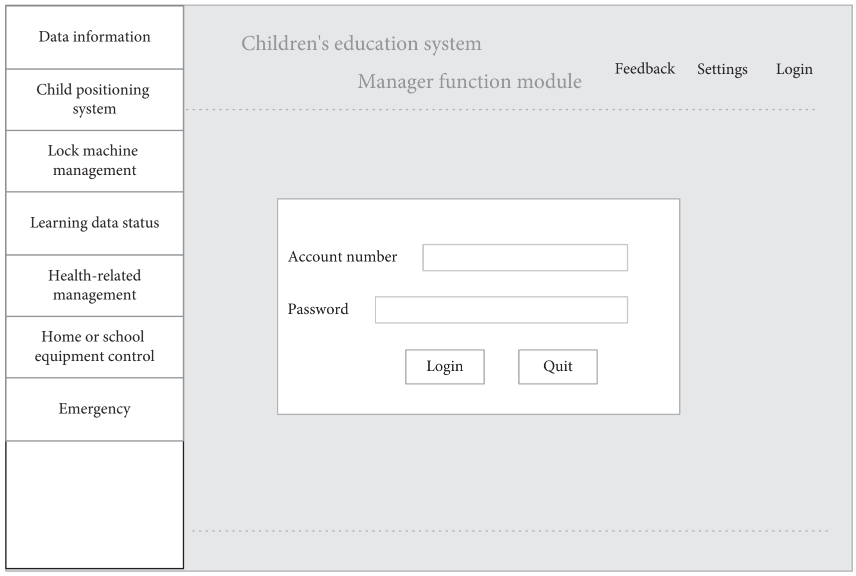

Figure 17: Manager module.

Constructing augmented Lagrange function:

$$L(x, y) = f(x) + \frac{1}{\alpha} y^T D^T x + \frac{1}{2\alpha} x^T Lx. \quad (21)$$

Solve with primal-dual algorithm:

$$\begin{aligned} \dot{x} &= -Lx - \alpha \nabla f(x) - Dy, \\ \dot{y} &= D^T x. \end{aligned} \quad (22)$$

(5) DGT:

$$\begin{aligned} \dot{x} &= -Lx - \alpha y, \\ \dot{y} &= -Ly + \nabla^2 f(x)\dot{x}. \end{aligned} \quad (23)$$

(6) Global objective function:

$$\min_{x \in R^n} \sum_{i=1}^{N} f_i(x). \quad (24)$$

(7) Convex analysis: convex functions:

$$f(\theta x + (1-\theta)y) \leq \theta f(x) + (1-\theta) f(y). \quad (25)$$

Strongly convex function:

$$(\nabla f(y) - \nabla f(x))^T (y - x) \geq \mu \|y - x\|^2. \quad (26)$$

Smooth function:

$$\|\nabla f(y) - \nabla f(x)\| \leq L \|y - x\|. \quad (27)$$

4. Implementation and Test of the System

4.1. Development Platform and Environment. This system is mainly developed in Windows 10 operating system environment, using Java programming language, MYSQL database management, and Apache Mina technology to design the system framework. The development platform is Visual Studio 2018, the processor is AMD Athlon (TM) II P360 Dual-Core Processor 2.30 GHz, the running memory is 8G, and the simulation platform is MATLAB.

4.2. System Interactive Interface. The interface of children's education online monitoring system is shown in Figures 17 and 18, respectively.

4.3. System Simulation Test

4.3.1. UI Testing. First the basic function preparation test is carried out; if the system operation interface is reasonable, then the deeper function is tested; if the UI test does not meet the requirements, the system is directly redeveloped. After testing, there is no abnormality in the UI interface. We invited ten volunteers who are familiar with UI testing and made statistics on satisfaction recognition, as shown in Figure 19.

UI test results basically meet the requirements of users, but because everyone has personalized requirements, it is impossible to fully meet the requirements, and the UI interface needs to be improved in detail. It mainly depends on the tester's judgment feeling. UI test points are as follows: (1) the overall style of the page is unified, the layout is coordinated, the header and footer contents are complete and consistent, and the page framework is clear; 2) the fonts of the page are unified and coordinated, displayed normally, and have good effect; 3) the display of the page navigation bar and the content distribution spacing are reasonable; 4) the page organizes and designs the line thickness; 5) the page picture size, position, resolution, and horizontal and vertical directions are not stretched; and 6) the page reads normal pictures and correct addresses.

4.3.2. Performance Test. For users, they do not care about how the system works behind them, and they only care about

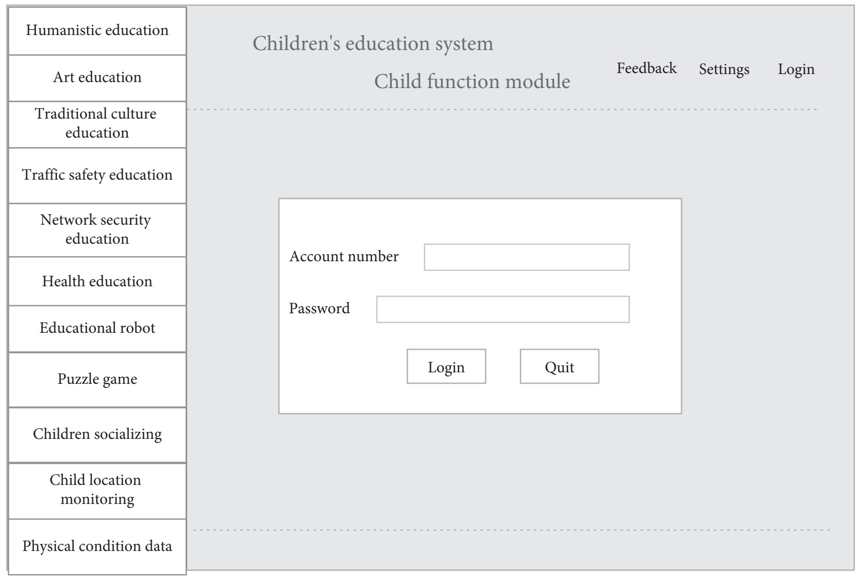

Figure 18: Children's module.

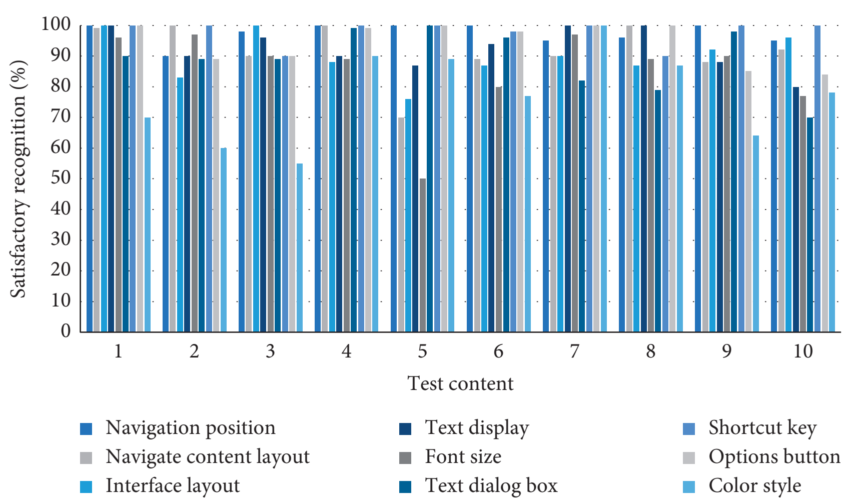

Figure 19: UI test results.

whether the system is "fast or not"; that is, the response time of the system is much less. In particular, for the vast majority of people, giving a response within 2 s is the best experience and the user is the most happy; giving a response within 5 s is a "fairly OK" experience; once the system response exceeds 10 s, the user experience is failed and uncomfortable. This test mainly tests the access time of the system, and the relevant calculation formula is as follows:

$$\begin{aligned}&\text{network transmission time} = N_1 + N_2 + N_3 + N_4,\\&\text{apply server processing time} = A_1 + A_3,\\&\text{database server processing time} = A_2,\\&\text{response time} = N_1 + N_2 + N_3 + N_4 + A_1 + A_3 + A_2.\end{aligned} \tag{28}$$

We set the numbers of visits requesting access to the system at the same time to 1000, 2000, 3000, 4000, and 5000. In the online monitoring system for children's education designed by us, the response time of the manager module and the children module is tested, respectively, and finally the submodules of the two systems are compared, as shown in Figure 20.

According to the results, we can find that the average response time of each request of children's module is about 725 ms, and that of managers is about 812 ms, which is about 12% higher than that of children's module. With more visits requested, especially more than 3000 times, the success rate of visits decreases greatly. The access success rate of children's module is 99%, the access success rate of manager module is 98%, and the response time is not more than 10 s. The user experience is very good.

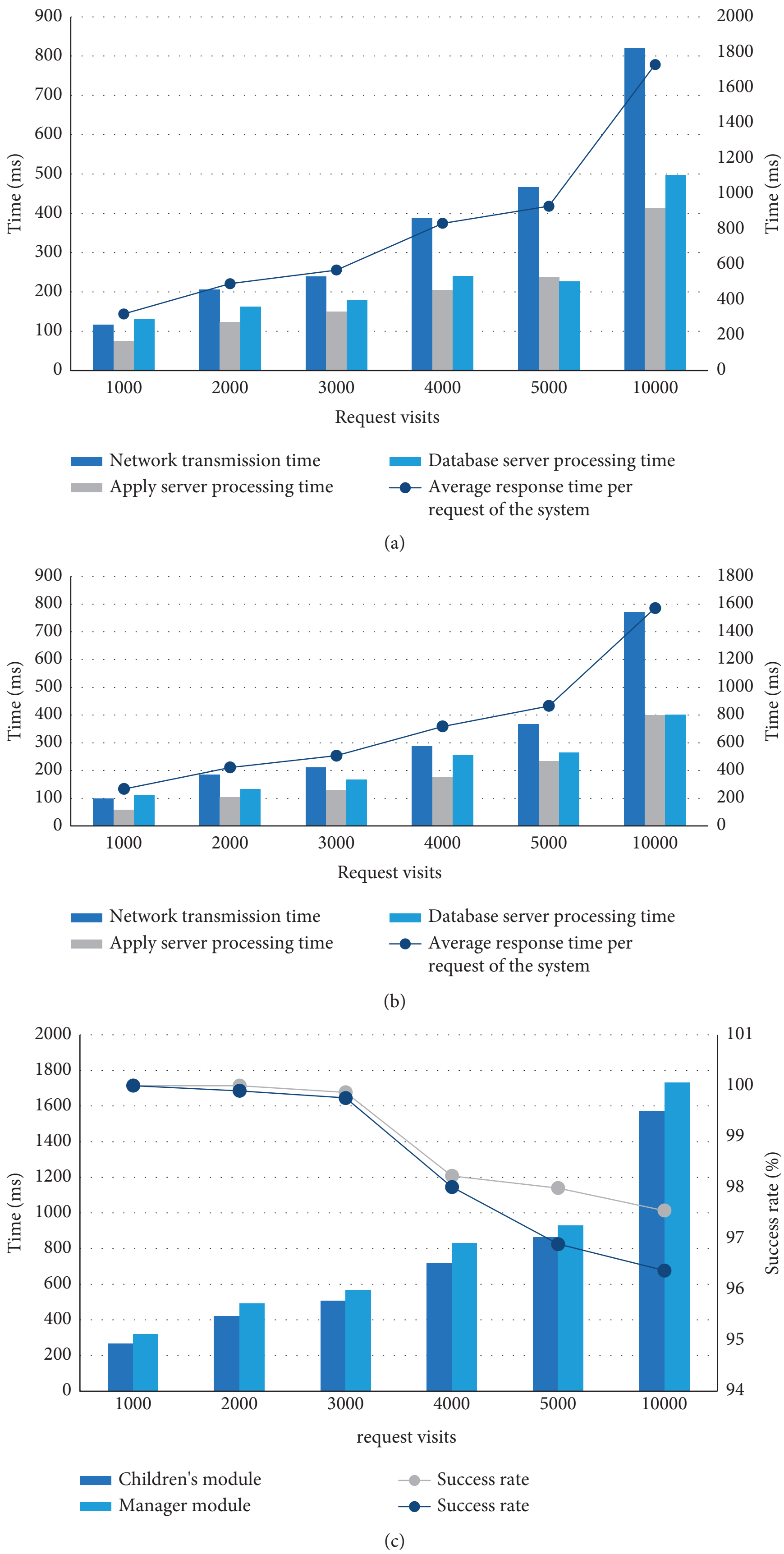

Figure 20: Response time test results. (a) Manager module. (b) Children’s module. (c) Comparison of two submodules.

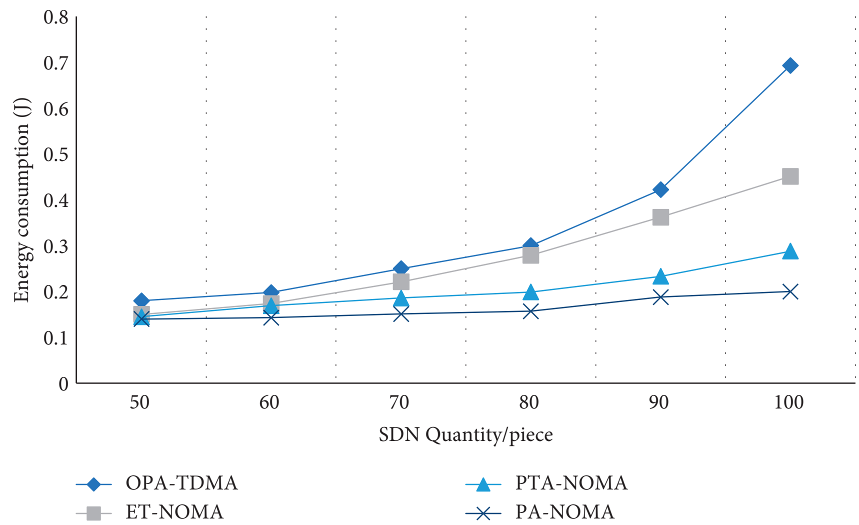

Figure 21: Comparison of optimized energy consumption with NOMA and TDMA.

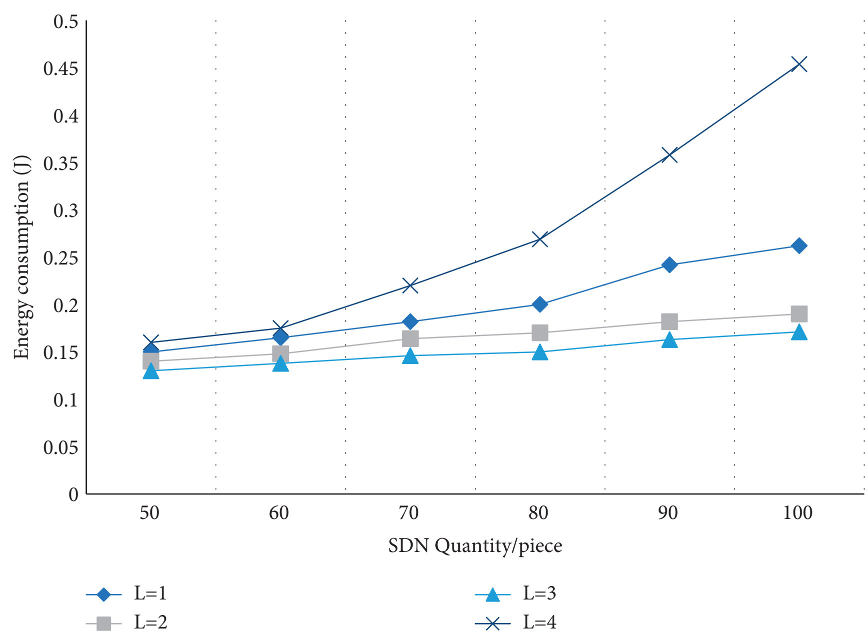

Figure 22: Relationship between optimized energy consumption and number of subchannels.

4.3.3. Optimization Test

(1) After the test optimization, the total energy consumption is shown in Figure 21.

According to the results, the energy consumption of PA-NOMA, ET-NOMA, and PTA-NOMA is greater than that of OPA-TDMA of TDMA when the amount of SDN increases. Compared with ET-NOMA, PA-NOMA greatly reduces energy consumption. Compared with PTA-NOMA, it can reduce the energy efficiency by more than 6%.

(2) After the test optimization, the total energy consumption and the number of subchannels allocated are shown in Figure 22.

According to the results, we find that when $L = 1$, the unmolecular channel is the same as PTA-NOMA. The total energy consumption at $L = 2$ is lower than that at $L = 1$; when $L = 3$, the total energy consumption is the lowest; when $L = 4$, the energy consumption is the largest. Therefore, the optimized energy consumption is the lowest, which can also verify the conclusion of Figure 21.

5. Conclusion

To sum up, the system designed in this paper for online monitoring of children's education has been developed, using the fifth-generation mobile communication technology, Internet of Things technology, distributed system development, and other technologies. According to the needs of schools, parents, and children, the practical application of children's education concept is carefully studied. The system is well developed and the simulation test results are good.

The results show the following: (1) UI test results basically meet the requirements of users; for the pursuit of personalized users, further development and improvement are needed. (2) Compared with children's module, the response time of manager module increased by 12%, and all the response times did not exceed 10 s, so the user experience was very good. The access success rate of children's module is 99%, and that of managers' module is 98%. It is necessary to further study what factors interfere with the success rate, which leads to the failure of 100% success. (3) After optimization, the total energy consumption is the lowest compared with NOMA and TDMA, which is the best energy efficiency optimization method to solve the communication of Internet of Things.

Therefore, our system can be further improved and updated and can be gradually put into market testing according to market research. In the follow-up, the developers' research work will focus on this system to improve more details, hoping to put it into market operation as soon as possible and bring about new technology convenience to children's education.

Data Availability

The experimental data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest regarding this work.

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