Hindawi
Wireless Communications and Mobile Computing
Volume 2022, Article ID 3174647, 11 pages
https://doi.org/10.1155/2022/3174647

Research Article

Design and Application of Interactive Teaching System for Electronic Engineering Specialty Based on ZigBee

Qian He

National University of Singapore, Singapore 119077

Correspondence should be addressed to Qian He; e0920471@u.nus.edu

Received 8 July 2022; Revised 22 August 2022; Accepted 29 August 2022; Published 21 September 2022

Academic Editor: Hangjun Che

Today, ZigBee technology has become one of the most widely used wireless communication technologies. Electronic engineering majors need a more efficient management system, which is supported by a database system to achieve overall learning management. The new system can improve students' dominance in moral education and student leadership. Therefore, this system will also bring educational leadership. At the same time, this system is also the first of its kind. It is an interactive system for communication between schools, students, and parents. It provides a timely and comprehensive platform for information retrieval and management and improves educational arrangements, educational management and students. Nowadays, various colleges and universities are constantly reforming and innovating their teaching management systems, and their teaching methods are also more diversified. This leads to the increased complexity of teaching management, and the existing teaching system software functions cannot meet the increasing demand. Therefore, this paper first introduces the concept and characteristics of ZigBee technology; then, the routing algorithm of the ZigBee network layer is used to analyze the role of the ZigBee technology in interactive systems. In the undergraduate class, applying the interactive teaching system proposed in this paper to student practice, experiments were also performed on this system. The results show that it can be found that in the daily teaching management and operation, the system meets a variety of operational and performance requirements, which is actually the test steps passed before the platform is deployed. In addition, based on the characteristics of ZigBee, the system platform has good practicability and is easy to maintain; after making corrections to the exposed problems, good experimental results have been obtained, and the purpose of the system has been achieved.

1. Introduction

Wireless information network technology is a new concept, often used for monitoring and identification in unguarded environments, and is made more regulated by expert physical layers and upcoming ZigBee standards. The rise of the information technology has stimulated the interest of Internet companies in research in this field [1]. Today, expert organizations are using ZigBee to effectively deliver solutions to multiple fields; the smart home grid is very flexible. The home application combines a variety of Internet communication technologies and forms a versatile platform to execute commands [2]. As an important communication field, wireless sensor network supports many new applications, such as monitoring, property management, factory automation, vehicle identification and so on [3]. MPWiNodeZ provides an array of mesh acquisition devices ready to be deployed in the vineyard. The equipment not only includes the hardware composition and environment of the test system, but also measures the performance of the equipment in the environment. The process should be paid attention to ecological protection, which is essential to achieve self-sustaining operation [4]. Internet companies are deepening their research on ZigBee technology, focusing on online communications and efficient education. The ZigBee Alliance has identified a number of areas for the technology: electronics production, environmental monitoring, teaching systems, etc. [5]. Realizing interactive learning has been the biggest problem

of electronic engineering professional teaching for many years, which has affected the interest of teachers and students in learning; in the teaching system of introducing the entry learning unit of electronic engineering student courses, the use of professional teaching methods is very effective [6]. The authors demonstrate an educational approach based on the concrete application of the concept of quality to the development of a digital electronics laboratory course over two academic years, with achievement levels and student evaluations indicating that goals have been achieved. Furthermore, the interdisciplinary nature of this approach allows it to be applied to other disciplines [7]. CDIO is MIT's current classic technical education model, emphasizing that technical education must focus on practice, be based on modern science and technology, rooted in the real-life cycle of products or systems, and aim to cultivate new high-level talents [8]. The methods of reforming electronic engineering major in many domestic universities make this major more extensive and have been praised and supported by government policies. These policies require that all programs be inclusive and develop specific graduate attributes [9]. In the European higher education, we describe the gold content of a professional degree in electronic engineering from universities in the region; the purpose is to clarify the completed professional work, and to make an evaluation to better fill the previous mistakes [10]. The British government published the policy mainly to improve the interactive teaching in colleges and universities and to apply it to practice. When the activity courses involving various technologies were concerned about the interactive teaching cases, the policy clarified how students use the ICT information resources, which enhances the potential of students when working independently [11]. In recent years, the theory of digital information processing has been upgraded from a low-level approach to an advanced level, and the curriculum has evolved to a core part of expertise. This paper summarizes the basic theory and applications of information processing and introduces the interactive teaching methods that it applies in the 24-hour course practice [12]. We created a classroom interactive teaching tool to monitor students' learning, aiming to understand the effectiveness of classroom teaching strategies, while designing a program for using teaching tools to gather information [13]. The Zambia survey investigated the system of ZigBee technical support for applying interactive teaching to classroom practice. This project explores the types and use methods of wireless information technology, which can achieve interactive teaching by creating a network environment and actively explore in the school teaching curriculum [14]. As a teaching mode commonly used in the electronic engineering professional teaching, the teaching management system design rarely studies the hardware equipment or the requirements for the equipment are not high, and the students are able to learn for the system practice is efficient [15].

2. Introduction to ZigBee Technology

2.1. Overview of ZigBee Technology Development. Compared with other wireless communication technologies, ZigBee technology has significant performance advantages, and its scope is constantly expanding. Further optimizing network performance and solving some problems encountered by this technology have gradually become the focus of research. The continuous development and improvement of network specifications and their applications have attracted the research of many universities and commercial companies in communication technology. Their focus is mainly on two aspects: the standard and perfect system of ZigBee protocol specifications and ZigBee technology applied to teaching systems and product design.

2.2. ZigBee Protocol Stack. The ZigBee protocol stack framework simplifies the network communication protocol model into physical layer, network layer, and application layer, making the protocol easier to understand. According to the IEEE 802.15.4 standard, the Communication Alliance has configured the standard protocols of the network layer and the application layer. The application object specified by the manufacturer uses the frame layer to share APS and security services with ZDO. The ZigBee protocol framework is shown in Figure 1.

2.3. IEEE802.15.4 Standard. Completed in May 2003, the IEEE 802.15.4 standard protocol is a communication specification for slow wireless personal area networks. Through its low energy consumption characteristics, the standard strives to provide a unified standard for slow connections between different devices accessible to individuals or homes. Compared with other wireless protocols, it has the advantages of strong networking capability, high efficiency and low energy consumption.

2.4. ZigBee Network Layer Specification. The network layer, application layer, and related security configurations are all based on the physical IEEE 802.15.4 layer and the media access control layer. The network layer allows the MAC layer to work properly and provide services for the application layer, while the NLME is responsible for the application layer management services, including the ability of routers or coordinators to join or leave the network; network related devices (end nodes) assign addresses, neighbor identification and route detection through coordinators or routers.

2.5. ZigBee Application Layer Specification. The application layer is mainly composed of the application support sublayer, device objects, and application objects specified by the manufacturer. The key functions of the application support layer are the data transmission between interface devices, the maintenance of the binding table, and the APS communication mechanism. The so-called bundling is to bind two devices according to their own needs and services. The application support sublayer is used to connect the application layer and the network layer. The function of the device object is to define the role of the device on the network, create a security mechanism, and respond to the user's request. Bind requests, search for existing devices on the network, and terminate application services in favor of their provisioning devices.

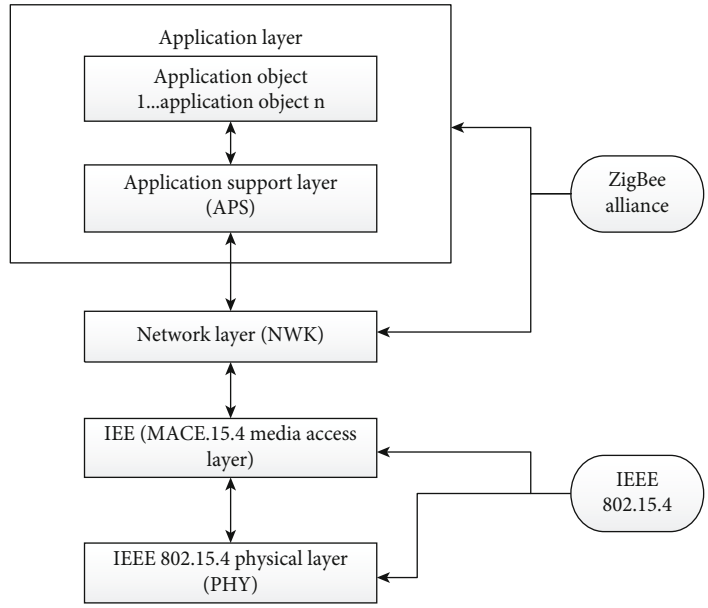

Figure 1: ZigBee protocol framework.

3. Basic Routing Algorithm of ZigBee Network Layer

3.1. ZigBee Address Allocation Mechanism. The master node of the ZigBee network combines the distributed address allocation algorithm (DAAM) to assign address segments and 16-bit short addresses to child nodes, allowing nodes to build logical structures. The exact addressing process is as follows: The ZigBee network addressing process has three important parameters: L_m, C_m, and R_m. These are defined by the coordinator at the beginning of the network construction. Usually, the size of the address assigned by the parent node to the child node is calculated as shown in Formula (1), and $C_{skip}(d)$ is set as the address offset:

$$C_{skip}(d) = \begin{cases} 1 + C_m \cdot L_m - d, & R_m = 1 \\ \dfrac{1 + C_m - C_m \cdot R_m^L}{R_m + 1}, & R_m \neq 1 \end{cases}. \quad (1)$$

Typically, the coordinator depth in a ZigBee network is set to 0, and other nodes in the network increase the current depth from top to bottom according to their positions. The master node assigns an address 1 greater than its own address to the first added FFD child node and then uses the following formula to represent the associated node; if it is A, this node is the end node. Together with the various child nodes of the network, address determination can be made according to the following formula:

$$A_i = A_p + C_{skip}(d) \cdot (i - 1) + 1, i \in [1, R_m]. \quad (2)$$

The network address of the p-th endpoint whose parent is

$$A_n = A_p + C_{skip}(d) \cdot R_m + n, n \in [1, C_m - R_m]. \quad (3)$$

The calculation result of the maximum number of nodes that the ZigBee network can accommodate is shown in the following formula:

$$N_{total} = C_{skip}(0) \cdot R_m + (C_m - R_m) + 1. \quad (4)$$

3.2. Cluster Tree Algorithm. The cluster tree algorithm is a hierarchical routing algorithm of the static type, in which packets are sent and forwarded through a tree topology. This algorithm is often used when the ZigBee network topology is a cluster tree. If FFD is the target node, the node responds to the top level. Otherwise, the following formula can be combined to evaluate whether the child node corresponds to the target node, as follows:

$$A < D < A + C_{skip}(d - 1). \quad (5)$$

So the following formula can be used to specify the next hop address required to reach the child node.

$$N = \left(\frac{D - A - 1}{C_{skip}(d)} \right) \cdot C_m + A. \quad (6)$$

3.3. Common Performance Indicators of Routing Protocols. The purpose of NS2 simulation is to compare the performance of ZigBee routing protocol Cluster tree, AODvjr, and ZBR in different network scenarios. In general, we choose the following dimension metrics when evaluating and analyzing the performance of routing algorithms, which are defined as follows:

(1) The packet delivery rate GK is an important indicator to measure the accuracy of the routing protocol, and the delivery rate of the data packet is shown in the following formula:

$$G_k = \frac{G_d + 1}{G_s}. \tag{7}$$

(2) Average end-to-end delay: The average end-to-end delay of all successfully transmitted packets, this indicator shows the degree of network congestion and the real-time nature of network data to be transmitted. Let M be the number of packets successfully delivered to the destination node, $t_d(i)$ is the time when the packet is received, and $t_s(i)$ is the time when the packet is sent, so the end-to-end average delay is defined as follows:

$$\overline{T_d} = \frac{1}{M}\sum_{i=0}^{M}[t_d(i) - t_s(i)]. \tag{8}$$

(3) The routing cost reflects the average number of control packets required to transmit a data packet. Assuming that M groups of data packets are transmitted, the corresponding average routing cost is as follows.

(4) Node survival rate is used to represent the energy balance of the network. The specific definition is as follows: that is, the ratio of the number of surviving nodes in the network to the total number of nodes after the network runs for a certain period of time. The specific definitions are as follows:

$$\text{Node Survival Rate} = \frac{\text{Number of Surviving Nodes}}{\text{total number of nodes}}. \tag{9}$$

(5) The remaining energy of the network is easy to understand, and the continuous operation of the ongoing network will continue to consume node energy. Therefore, the calculation formula of the residual energy of the network is as follows:

$$\text{Network residual energy} = \sum \text{residual energy of a single node}. \tag{10}$$

3.4. Classification of ZigBee Clock Synchronization Algorithms. In the whole wireless sensor network, the main reasons for clock synchronization are the difference of hardware clock frequency and transmission delay. At present, the more mature clock synchronization algorithms are mainly divided into two categories.

Based on the transceiver bidirectional clock synchronization algorithm, each node synchronizes time with its superior node through bidirectional message synchronization and finally synchronizes between all nodes and the master node. When the local time of node B is T, the time between node A and node B is T. When the clock offset is Δ, there is

$$T_2 = T_1 + \Delta + d. \tag{11}$$

In the case of clock skew, the formula is as follows:

$$T_4 = T_3 - \Delta + d, \tag{12}$$

can be calculated

$$\begin{aligned} \Delta &= \frac{(T_2 - T_1) - (T_4 - T_3)}{2}, \\ d &= \frac{(T_2 - T_1) + (T_4 - T_3)}{2}. \end{aligned} \tag{13}$$

Node B changes its local time to $T_4 + \Delta$ at time T_4 so that it can achieve synchronization with node A at this time.

Based on receiver-receiver clock synchronization algorithm, its working principle is not to synchronize the time of the sender and the receiver, but to synchronize the received time. According to the time synchronization statistics, it can be assumed that the receiver receives the reference synchronization message at the same time. Based on the continuous interest rate model, it is assumed the following:

Node 1's local clock is

$$c_1(t) = \alpha_1 + \beta_1 t. \tag{14}$$

Node 2's local clock is

$$c_2(t) = \alpha_2 + \beta_2 t. \tag{15}$$

The local clock skew of the 2 nodes is

$$offet(t) = (\alpha_1 - \alpha_2) + (\beta_1 - \beta_2)t. \tag{16}$$

For a given time, a set of clocks offset data can be obtained, and a least squares linear regression method is used to fit the offset data. The intersection of the resulting lines is the original clock skew of the two nodes, and the slope of the line is the clock skew of the two nodes.

3.5. Algorithm Error Analysis. When analyzing the clock synchronization error according to the principle of the TPSN algorithm, the influence of the transmission time and the access time on the error is eliminated. Assuming that the local times of the two nodes in the synchronization process are t_1, t_2, respectively, the following formula can be

obtained:

$$t_2 = t_1 + S_A + P_{A\longrightarrow B} + R_B,$$
$$\begin{cases} T_2 = T_1 + S_A + P_{A\longrightarrow B} + R_B + D_{t1}^{A\longrightarrow B} \\ D_t^{A\longrightarrow B} = D_{t1}^{A\longrightarrow B} + RD_{t\longrightarrow t4}^{A\longrightarrow B} \end{cases}. \quad (17)$$

T_1, T_2 is the time measured by the local node corresponding to t_1, t_2, S_A is the time when the parent node information is sent, $P_{A\longrightarrow B}$ is the time when the synchronization data packet is propagated from the parent node to the child node, R_B is the processing time of the child node information receiving process, and $D_t^{A\longrightarrow B}$ represents the clock offset between the parent node and the child node at time t_1.

Similarly, T_4 can be obtained:

$$T = T_3 + S_B + P_{B\longrightarrow A} + R_A + D_{t1}^{B\longrightarrow A}. \quad (18)$$

In summary, the clock skew can be obtained:

$$\Delta = \frac{s_A - s_B}{2} + \frac{R_B - R_A}{2} + \frac{RD_{t\longrightarrow t4}^{A\longrightarrow B}}{2}. \quad (19)$$

Therefore, the synchronization error can be calculated as

$$Error = \Delta - D_{t\longrightarrow t4}^{A\longrightarrow B} = \frac{s_A - s_B}{2} + \frac{R_B - R_A}{2} + \frac{RD_{t\longrightarrow t4}^{A\longrightarrow B}}{2}. \quad (20)$$

In order to analyze the clock synchronization error between the routing node and the end node, according to the basic principle of the DMTS algorithm, the sending node A sends and starts the preamble synchronization word at time t, and the receiving node B adds a timestamp. Send a timestamp to the message when the message arrives, register the current local time before setting the local time, and adjust the local clock to the specified time; you can get

$$\begin{cases} T_2 = T_0 + T_B + P_{A\longrightarrow B} + R_B + D_{t1}^{A\longrightarrow B} \\ D_{t0}^{A\longrightarrow B} = D_{t1}^{B\longrightarrow A} + RD_{t0\longrightarrow t4}^{A\longrightarrow B} \end{cases}. \quad (21)$$

Among the many time synchronization algorithms in wireless sensor networks, the delay measurement time synchronization (DMTS) algorithm is widely used because of its simple principle, low computational complexity, and low energy consumption, but its accuracy and stability are insufficient. Finally, the error of the DMTS is obtained as

$$Error = \Delta - D_{t\longrightarrow t4}^{A\longrightarrow B} = P_{A\longrightarrow B} + T_{error} + R_{error} + RD_{t0\longrightarrow t4}^{A\longrightarrow B}. \quad (22)$$

Although the TPAN algorithm has high accuracy, it must send 2 messages and synchronize after receiving 2 messages, resulting in a total power consumption of 4 messages; the DMTS algorithm is less accurate but only needs to send 1 message and receive 1 message Sync once, consuming 2 messages in total. By combining wireless sensor networks, the advantages of both ensure network power and network power consumption.

4. Realization of Interactive Teaching System Platform

4.1. Design of Interactive Teaching System. The interactive teaching system created above is aimed at teachers and students majoring in electronic technology in South China University of Technology, and all the courses involved are based on the electronic technology courses in South China University of Technology. The purpose of the system is to design a new interactive e-learning assessment system focused on improving the entire teacher assignment process and coursework grading, bringing students' work closer to real business teamwork to complete tasks, improve skills, expand knowledge to improve Competitive job market. Compared with the previous offline process of organizing and judging coursework, the interactive course evaluation system proposed by the system aims to provide teachers with more valuable reference information, while reducing the workload of teachers to evaluate courses. Previously, our student evaluation and coursework the evaluation is ultimately based on a percentage as the result of the evaluation. Every student has his own strengths and embodies his own qualities in many ways. Students may not perform well on exams, but have excellent coding skills and are team players. If the previous grading method is used, there is no way to show his/her interest, see from the transcript how the student did this. Therefore, we need a new grading system that includes multidimensional assessment metrics that allow for multidimensional assessment not only of each coursework, but also of each student at the end of the course.

4.2. Functional Analysis of Interactive Teaching System. In this system, the users include teachers and students. Among them, the administrator has the most authority and can manage other users arbitrarily. The interactive teaching system designed here uses SQL Server database to run the system. The database mainly includes the following data tables: user table, teacher table, student table, administrator table, curriculum table, announcement table, topic table, reply topic table, and courseware on-demand table. The composition of several main tables is briefly introduced:

(1) Work unit Table 1

(2) Teacher table, used to record some information of teachers, as shown in Table 2

(3) Student table, used to record student information, as shown in Table 3

(4) Table of discussion content, as shown in Table 4

Table 1: Worksheet.

Field name	Data type	Major key	Is it empty	Field description
Id	Text	Yes	Not null	Job number
Zxuehao	Text		Not null	Student ID
Ztihao	Text		Not null	Homework question number
Zzhengwen	Text		Null	Homework body
Zchengji	Figure		Null	Homework results
Zkecheng	Text		Not null	The course
Zjianshi	Text		Not null	Class teacher
Zbiaoshi	Text		Not null	Job identification
Zbezhuu	Text		Null	Homework remarks
Zshijian	Text		Not null	Submission time

Table 2: Teacher table.

Field name	Data type	Major key	Is it empty	Field description
Jjiaoshi	Text	Yes	Not null	Teacher number
Jxingming	Text		Not null	Teacher's name
Jxingbie	Text		Not null	Teacher gender
Jbumen	Text		Null	The department
Jdianhua	Text		Null	The teacher telephone
Jemai	Text		Null	Teacher email
Jzhicheng	Text		Null	Teacher title

Table 3: Student table.

Field name	Data type	Major key	Is it empty	Field description
Xxuehao	Text	Yes	Not null	Student ID
Xxingming	Text		Not null	Name of student
Xxinbie	Text		Not null	Student gender
Xbanji	Text		Null	The class
Xdianhua	Text		Null	Student telephone
Xdianyou	Text		Null	Student email

(5) User table, used to record user information, as shown in Table 5

(6) The student's achievement table, as shown in Table 6

4.3. System Experiment. In order to evaluate the feasibility of this evaluation system, the interactive education system developed in this paper is mainly used in the teaching of electronic engineering majors in the School of Software. We selected students from two undergraduate classes of electronic engineering in South China University of Technology for experimental comparison; the practicability of the system can be verified. The experiment is about the evaluation system proposed by the subject of IT project management on the interactive teaching system. There are 6 groups, and the best student is selected as the group leader. Figures 2 and 3 are the experimental results of the 2018 electronic engineering class 6 group and teachers in the IT project management course.

From the score distribution in Figure 2, it can be seen that if the captain has too much power, it is no problem to give himself a high score, but the experimental results are not ideal. After communicating with classmates, I noticed that not all team members have the same score. Participate in the project in a way that the team leader is particularly concerned about low-scoring team members developing psychological imbalances and being ashamed of themselves for underperforming. For example, the tasks assigned by the teacher to each group of algorithm classes may be different algorithms, and if the students in each group only participate in the assignments of that group, the impact of the coursework will be greatly reduced due to the unintended teacher. As shown in Figure 3, the peer review results among the groups are in good agreement with the final teacher's evaluation results, and the expected effect is achieved.

Figure 3 shows that when peer review and group-to-group grading are introduced, it can stimulate thinking and expand students' knowledge without burdening many students. Secondly, the students checked the homework of other groups and gave each indicator a score in their hearts, which is also a good reference for the teacher, and it is very helpful for the teacher to understand the quality of each homework; according to the experimental results, students are also able to take peer review very seriously and responsibly.

Learning from the failure of the last experiment, we decided that the total score for each group of students is 100 so that students can compromise between workload and grades. In addition, the teacher suggested that the students should be different in the evaluation, instill the idea of investing in the evaluation, and try to let the team leader free his hands and feet to evaluate. The data of this experiment are shown in Figure 4. It can be seen that except for the fifth group, the score distribution of the other six groups is very ideal, providing very effective reference information for teachers. The peer-reviewed results are shown in

Table 4: Content table.

Field name	Data type	Major key	Is it empty	Field description
Ccid	Text	Yes	Not null	Number
Users	Text		Null	Debater
Ctime	Text		Not null	Published time
Cisid	Text		Not null	Subject number
Content	Text		Null	Published content

Table 5: User table.

Field name	Data type	Major key	Is it empty	Field description
Uid	Figure	Yes	Not null	User number
Login	Text		Not null	Accession number
Name	Text		Null	Name of user
Pass	Text		Not null	User password
Urid	Figure		Not null	User role

Table 6: Results table.

Field name	Data type	Major key	Is it empty	Field description
Ccid	Text	Yes	Not null	Job number
Xuehao	Text		Not null	Student ID
Keming	Text		Null	Course title
Chengji	Text		Null	Homework results

Figure 5, which are the same as the previous experimental results and also meet expectations' effect.

The experimental results in Figure 5 show that the previous rule design was flawed; even if the team leader wanted to be a good person, he did not want to score based on the actual contributions of team members. After improving the plan, the team leader can score according to the actual contributions of team members, who have achieved good experimental results and achieved the goals of the system.

4.4. System Function Test. Apart from resource usage, scalability, system capacity (concurrency, etc.), and system stability, software performance is first expressed in response time. The system is used to manage the daily education of the school, including notification management, file management, system note management, personal user information management, course management, and other functions. The main significance of performance testing is to ensure that the functions of the system meet the requirements of users. The scene description of the functional test is shown as follows in Table 7.

The measured hardware foundation of this platform is shown in Table 8.

4.5. System Performance Comparison. System performance includes the following aspects:

(1) Security test: For the security test of the system, the user needs to input information in the system, and the system will determine and analyze the information. If the information is incorrectly entered or three consecutive errors are made, the entire system will be locked, and the user will be given a certain prompt, requiring the system to run for a long time, and there will be no abnormal situation or occurrence, and all functions can be performed normally

(2) Sustainability test: The operation and operation of the entire system are coherent, and there will be no abnormal situations such as freezes, which can detect whether the system can run smoothly

(3) Failure handling speed test: After the system fails, the system can be restored immediately, and the recovery time of the entire system does not exceed 30 minutes

(4) Efficiency test: The system requires simulated multi-user access to the system, and the system will not appear abnormal and maintain normal operation. When an exception occurs, you can immediately switch to the backup server and notify the relevant personnel to solve and deal with it

(5) Response time test: For users, it is required to provide a fast and stable system. If the running time is too long, the user cannot accept this system

4.5.1. Internal Data Throughput Comparison. The comparison results of the measured data throughput of the interactive system based on the ZigBee method with conventional LPWAN techniques are shown in Figure 6. Throughput refers to the total amount of data transmitted over the network during a performance test. For interactive applications, throughput metrics reflect the stress on the server. In Figure 6, the data throughput corresponding to the surge in the number of accessing users can meet the operating requirements and meet the design conditions of the teaching system.

It can be seen from the comparison of the internal data throughput of the teaching system operated by ZigBee technology and traditional LPWAN technology in Figure. The results show that the system of ZigBee technology can maintain a higher throughput and a more stable system. Different from LPWAN technology, in the case of the same number of users under the hood, ZigBee provides more data throughput with low power consumption.

4.5.2. Comparison of Fast Response Performance. Figure 7 shows the comparison of the response time performance of the learning system run by ZigBee technology and traditional LPWAN technology. In the comparison of the measured feedback results of the fast response system supported by the two technologies in Figure 7, the response time between 1.5 s and 2 s is the average value, and the

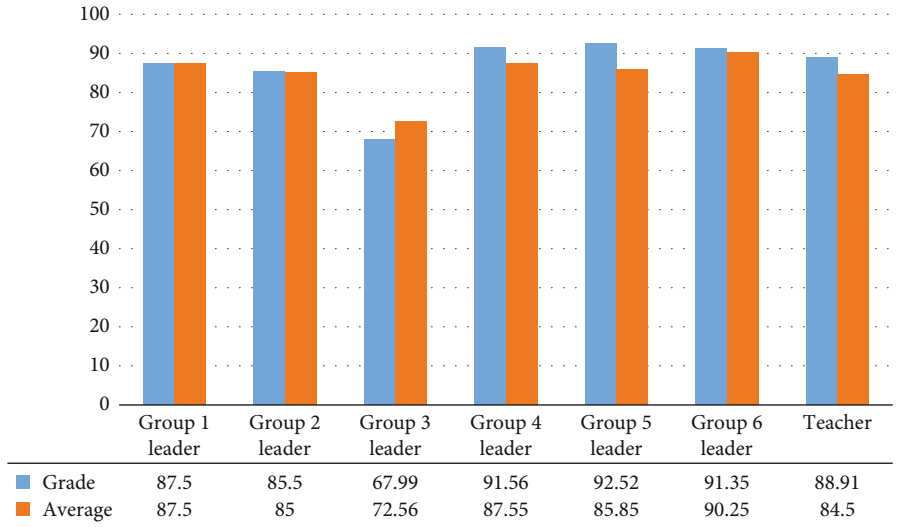

Figure 2: 2018 grade 6 electronic engineering 6 team leader's score and teacher's score results.

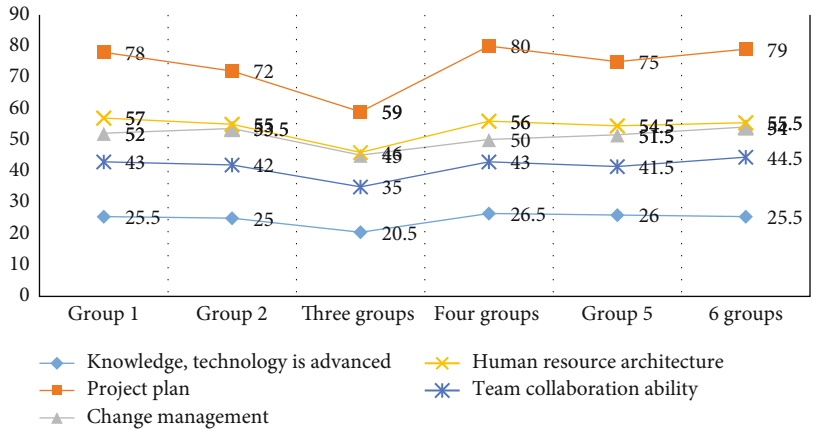

Figure 3: Mutual evaluation results between 6 teams of 2018 software engineering.

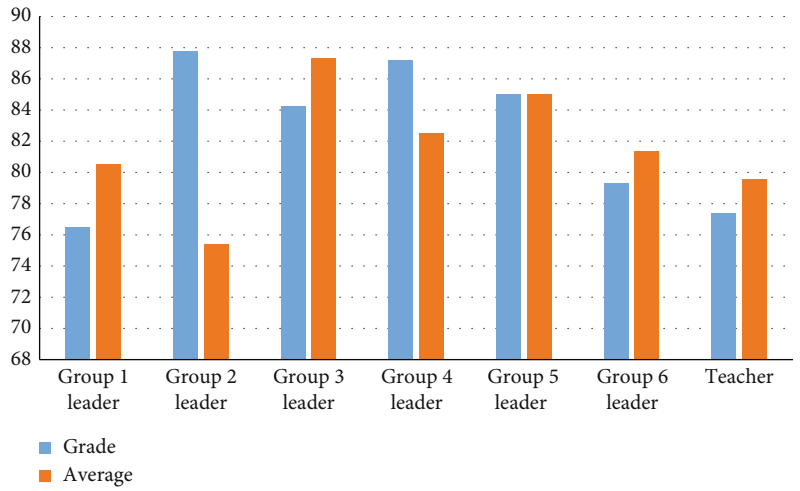

Figure 4: 2018 grade 5 software engineering 5 team leader's score and teacher's score results.

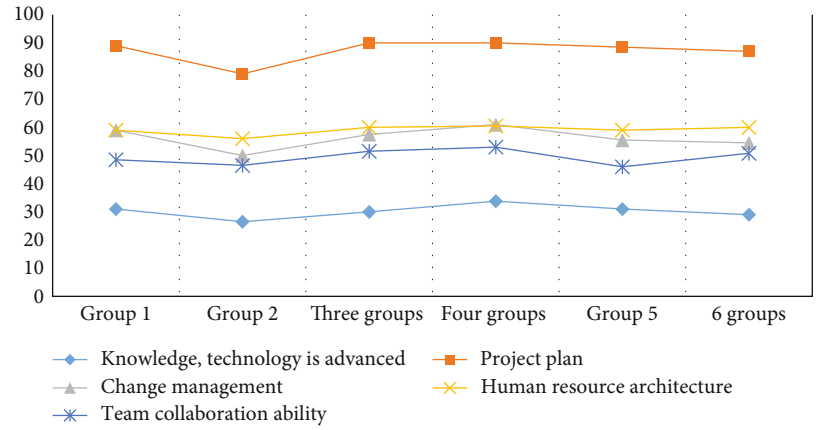

Figure 5: Mutual assessment results between the 5 teams of 2018 software engineering.

Table 7: Test scenario description.

Test script description	IE interface login, consult the schedule, download the schedule, and modify personal information		
Number of virtual users	600	User login mode	Log in to 4 accounts every 3 seconds
Load run time	50 minutes	User exit	There are 10 accounts in total every 3 seconds
Concurrent point experiment mode	View information	Number of concurrent users	200

Table 8: Measured hardware basis.

Server	HP RP4440
CPU	8CPU
Internal storage	16G memory
Caliche	146G*2
Network	100 M broadband
Operating system	UNIX
The web service running environment	WebSphere5.0
IE edition	IE7.0
Data base	SQL server

system performance indicators and parameter values under extreme operating conditions (excessive user access at the same time) are only slightly higher than 3 s. This time is perfectly acceptable in normal use and is in the fully user-acceptable time frame compared to multiuser latency.

The comparison results of Figure 7 illustrate that the system of ZigBee technology can meet the dual requirements of operation and performance in daily training management and operation. Up to 200 users who use the system alone cannot meet any operational problems. Except for a delay of about 1.5 seconds, there are no other problems. Meanwhile, the system supported by ZigBee technology has a shorter response time than the LPWAN, and the interval time is less, and ZigBee technology is more dominant in the comparison of fast response performance. At present, the precommissioning stage of the platform has been basically completed, and the system platform has strong portability and easy maintenance due to the characteristics of ZigBee.

Since the system supports multiple users to access data concurrently, it is necessary to monitor the performance characteristics of the server. For the teaching system supported by ZigBee and LPWAN technologies, Loadrunner is used to cooperate with users to test the software performance. After analysis, the comparison of the test results is shown in Figure 8.

By comparing the performance test results of the CPU occupancy rate test results of the teaching system supported by ZigBee and LPWAN technologies in Figure 8, the results show that as the number of users increases, the response speed of the platform always keeps up, and it is not affected by users. Under the same conditions, the CPU occupancy of the system of ZigBee technology is low, which is more convenient for users to operate and use, and can also aggregate more resources.

5. Conclusion

The application description of the interactive teaching system supported by ZigBee technology basically meets the requirements of the school management system in terms of its function and practicality and also achieves the initial goal of establishing the system. After completing the application experiment of the teaching system, I have a deeper understanding of the entire B/S architecture software development process. The design of each link is very important; another in-depth experience needs to be considered. If you really want to learn and master JSP, you still need to have a deeper understanding of Java in order to truly understand the development benefits of JSP. In the long process of system development, it is not only a test of my technology, but also a test of my will and quality. I am very happy that I have

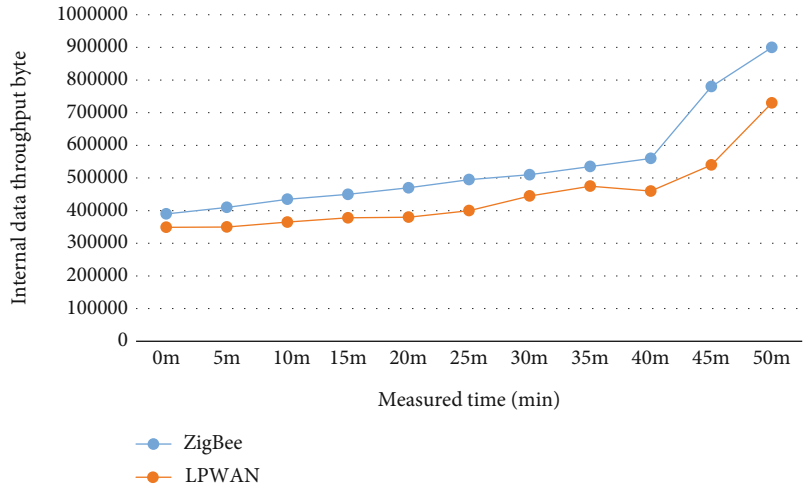

Figure 6: Internal data throughput comparison.

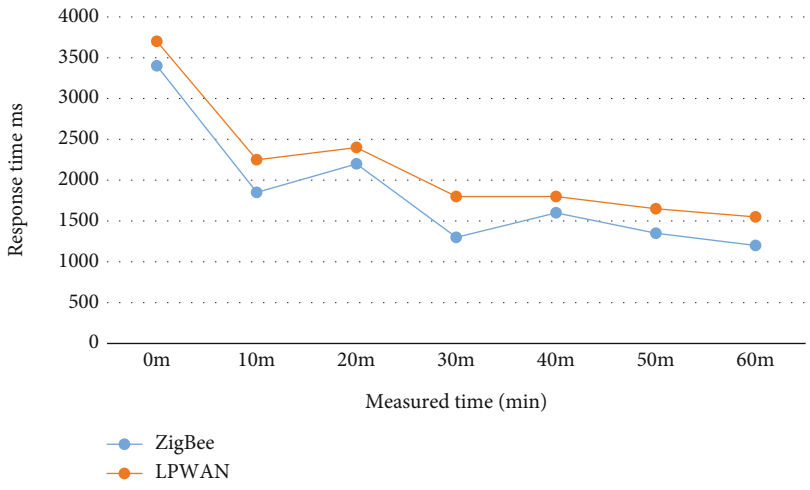

Figure 7: Comparison of fast response measured feedback results.

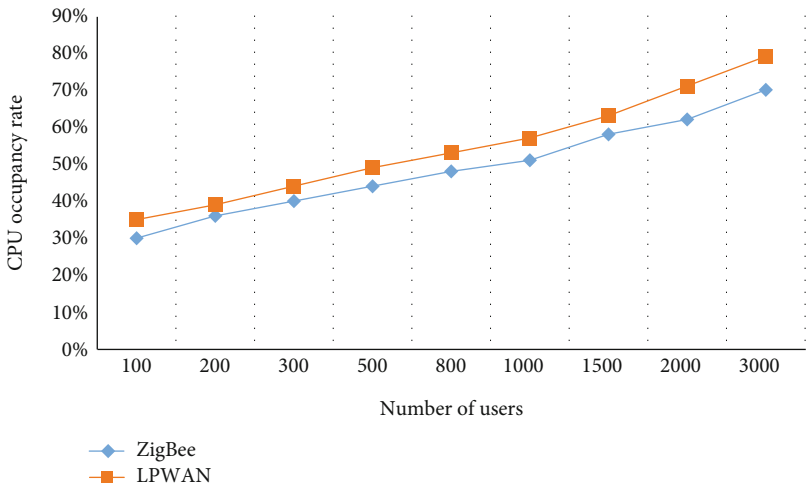

Figure 8: Comparison of system CPU usage test results.

overcome many difficulties and finally completed the development of the system. Interactive teaching system is a kind of interactive or online learning different from traditional teaching methods. It is the starting point of modern education reform and also the hot spot of information technology. In terms of security, because the system design is aimed at the student group, the confidentiality requirements are not very high, and no attention is paid to the security design; in software testing, the time in the testing phase has not reached the testing intensity of commercial software products, and it has not been able to strive for excellence.

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 declared that they have no conflicts of interest regarding this work.

References

[1] P. Baronti, P. Pillai, V. Chook, S. Chessa, A. Gotta, and Y. F. Hu, "Wireless sensor networks: a survey on the state of the art and the 802.15.4 and ZigBee standards," *Computer Communications*, vol. 30, no. 7, pp. 1655–1695, 2007.

[2] D. M. Han and J. H. Lim, "Design and implementation of smart home energy management systems based on ZigBee," *IEEE Transactions on Consumer Electronics*, vol. 56, no. 3, pp. 1417–1425, 2010.

[3] P. Kinney, "ZigBee technology: wireless control that simply works," *White Paper*, vol. 33, no. 6, pp. 2158–2179, 2003.

[4] R. Morais, M. A. Fernandes, S. G. Matos, C. Serôdio, P. J. S. G. Ferreira, and M. J. C. S. Reis, "A ZigBee multi-powered wireless acquisition device for remote sensing applications in precision viticulture," *Computers and Electronics in Agriculture*, vol. 62, no. 2, pp. 94–106, 2008.

[5] D. Egan, "The emergence of ZigBee in building automation and industrial controls," *Computing & Control Engineering Journal*, vol. 16, no. 2, pp. 14–19, 2005.

[6] E. Montero and M. J. Gonzalez, "Student engagement in a structured problem-based approach to learning: a first-year electronic engineering study module on heat transfer," *IEEE Transactions on Education*, vol. 52, no. 2, pp. 214–221, 2009.

[7] I. Plaza and C. T. Medrano, "Continuous improvement in electronic engineering education," *IEEE Transactions on Education*, vol. 50, no. 3, pp. 259–265, 2007.

[8] W. Wang, D. J. Wang, and A. M. Shen, "Reform and exploration of the mechanical and electronic engineering practice teaching system based on CDIO training model," *Journal of Anhui Normal University (Natural Science)*, vol. 5, no. 2, pp. 338–358, 2010.

[9] M. Ayre and A. Nafalski, *Recognising Diverse Learning Styles in Teaching and Assessment of Electronic Engineering, Frontiers in Education Conference*, IEEE Society, Mexico, 2010.

[10] J. Portilla, A. Varona, and N. Otegi, "Making explicit and reinforcing horizontal competences in an electronic engineering degree," *Procedia - Social and Behavioral Sciences*, vol. 141, pp. 961–968, 2014.

[11] S. Kennewell, H. Tanner, and S. Jones, "Analysing the use of interactive technology to implement interactive teaching," *Journal of Computer Assisted Learning*, vol. 24, no. 1, pp. 35–98, 2010.

[12] R. W. Stewart, M. Harteneck, and S. Weiss, "Interactive teaching of adaptive signal processing," *Engineering Science & Education Journal*, vol. 9, no. 4, pp. 161–168, 2000.

[13] D. M. Kerr, L. Kent, and T. C. M. Lam, "Measuring program implementation with a classroom observation instrument," *Evaluation Review*, vol. 9, no. 4, pp. 461–482, 1985.

[14] B. Hassler, S. Hennessy, and T. Lord, "An investigation of appropriate new technologies to support interactive teaching in Zambian schools (ANTSIT)," *Final report to DfID*, vol. 29, no. 1, pp. 199–203, 2011.

[15] K. Craig and F. Stolfi, "Teaching control system design through mechatronics: academic and industrial perspectives," *Mechatronics*, vol. 12, no. 2, pp. 371–381, 2002.