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Research on Teaching of Internet of Things Communication Technology Based on Project Task Drive

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Abstract: With the rapid development of Internet of Things technology, the teaching of Internet of Things communication technology has become an important part of modern education. However, the existing teaching of Internet of Things communication technology has problems such as the disconnection between theory and practice, insufficient practical ability of students, and lack of innovation. In order to improve students' understanding and application ability of Internet of Things communication technology, this paper introduces the project-driven teaching method (PBL). This method promotes students to master communication technology in the process of solving problems by involving them in actual project tasks, and improves their teamwork and autonomous learning abilities. Specifically, the teaching content includes the design of teaching tasks based on the AGV scheduling system. Students design and implement AGV scheduling systems based on different communication technologies, conduct simulation tests, build an Internet of Things experimental environment, and conduct actual operation verification. In this process, students can deepen their understanding of technologies such as CAN bus, RS485 bus, WiFi, Bluetooth, 5G, etc., and improve their problem analysis and problem solving capabilities in actual engineering. By refining task requirements and experimental links, students' control over data transmission rate, signal stability, and anti-interference ability has been significantly improved. This study shows that all groups have different levels of performance in terms of innovation, data transmission rate, and control accuracy improvement. First of all, in terms of innovation scoring, Group 5 receives the highest score of 10, indicating that it shows strong innovation in the design and implementation process.

1. Introduction

With the rapid development of information technology, the Internet of Things (IoT) technology is being used more and more widely in various industries. As its core component, IoT communication technology carries the key tasks of data exchange and interconnection between devices. Especially in the fields of intelligent manufacturing, automated logistics and intelligent transportation, the importance of IoT communication technology is becoming increasingly prominent. With the rapid development of technologies such as 5G, Wi-Fi, and Bluetooth, how to effectively apply these advanced communication technologies to practical engineering has become an important challenge in current IoT teaching and research.

This study aims to enhance students' understanding and application of IoT communication technology through a project-driven teaching method combined with the design and optimization of AGV (automatic guided vehicle) remote control system. Through practical operation, experimental design and enterprise visits, students can not only gain a deep understanding of the working principles of different communication technologies but also debug and optimize them in a real environment, improving their ability to solve complex engineering problems. This innovative teaching model can not only improve students' hands-on ability but also cultivate more engineering talents with innovative spirit and practical ability for the future development of IoT technology.

This paper first introduces the background and development of IoT communication technology in the introduction, and explains the purpose and significance of the research. Then, in the research method section, the implementation process of the project task-driven teaching method is explained in detail, including experimental design, teaching steps and evaluation criteria. Subsequently, the paper shows the performance and optimization results of students in different experimental tasks through data analysis, and conducts in-depth discussions to analyze the advantages and disadvantages of the experimental results. Finally, the paper summarizes the research results in the conclusion section, points out the innovations and shortcomings of the research, and proposes directions for future improvements.

2. Related Work

With the continuous development of IoT technology, the education field is also actively exploring how to apply it to teaching practice to improve educational effectiveness and students' learning experience. The Internet of Things (IoT) is a basic technology for creating smart spaces, which helps to improve the effectiveness of face-to-face and online education systems. Badshah et al. reviewed relevant research, discussed the solutions to traditional education problems, the challenges and potential of the transformation to smart education, and proposed a variety of intelligent solutions for smart education [1]. Silalahi et al. proposed an IoT training program that aims to help trainees understand the latest Internet technologies through expert guidance, especially in the field of electrical engineering. The training includes the display of scientific research results, the provision of IoT materials, simple programming training and practice. The survey showed that the student satisfaction rate was 93% [2]. Meylani evaluated the current strategies for Islamic education curriculum management. The study found that curriculum management should incorporate modern technology, improve digital capabilities, and update curriculum content to meet global developments [3]. Gökçearslan et al. studied the influence of pre-service teachers on the acceptance of IoT technology in education and proposed and tested a structural model to determine the acceptance of IoT technology in education. In the analysis of the survey results, it was found that 69% of teachers were willing to use IoT technology in education [4]. Srinivasulu et al. proposed an energy-efficient multi-path routing protocol for IoT based on a hybrid optimization algorithm. The optimal clustering was achieved through a modified teaching-learning optimization method, and the cluster head was determined using nonlinear regression pigeon optimization. The results showed that the scheme had a significant energy-saving effect compared with the existing technology under the influence of energy consumption and node density [5]. Alhasan et al. proposed an integrated model to investigate students' intention to use IoT services based on the technology acceptance model, technology readiness index and external factors. The study found that factors such as compatibility, enjoyment, and self-efficacy significantly affected students' perception of the ease of use and usefulness of IoT and had an impact on students' intention to use it [6]. Alzahrani used the technology acceptance model to analyze the impact of self-efficacy on the educational application of the Internet of Things. The results showed that teachers with higher technical confidence were more likely to believe that the Internet of Things technology was useful [7]. Mahariya et al. discussed in detail the Industry 4.0 technologies related to smart campuses, including IoT drone systems, smart campus energy monitoring, and artificial intelligence employment prediction models, and proposed challenges, suggestions, and future development directions [8]. Akila et al. proposed a deep learning student attention recognition framework for offline classroom evaluation, which can accurately evaluate students' classroom behavior and facilitate the management and implementation of teaching plans [9]. Alhalangy et al. analyzed previous studies and presented the current status of AI in EFL/ESL (English as a Foreign Language/English as a Second Language) teaching, including the application of intelligent teaching systems, autonomous learning, virtual reality, and natural language processing. The results showed that both teachers and students have the responsibility to use AI effectively and ethically [10]. Hsiao et al. explored the impact of teaching strategies combining gamification and the 6E model on high school students' IoT learning activities. The results showed that the gamification + 6E model group performed better in computer programming self-efficacy, IoT knowledge, and hands-on ability [11]. Existing research still has certain bottlenecks in the evaluation of the practical effects of IoT technology in education, interdisciplinary integration, and technology acceptance, and further in-depth exploration and verification are urgently needed [12].

3. Method

3.1 Teaching Methods

(1) Project-Based Learning

Project-driven learning (PBL) is a task-based teaching method that allows students to master knowledge and develop skills in the process of problem solving by involving them in actual projects. The communication technologies involved in the AGV (automatic guided vehicle) dispatching system, such as WiFi, CAN bus, RS485 bus and RFID, have a wide range of application scenarios, so the PBL method is very suitable.

In this course, teachers will design a series of teaching tasks based on the AGV scheduling system, such as:

Design and implement a WiFi-based AGV remote control system;

Research and optimize the application of CAN bus in a single AGV to ensure communication stability;

Use RFID for AGV path identification and precise navigation;

The communication interaction between AGV and other workshop equipment is realized based on RS485 bus.

During the project, students will consult materials, build experimental environments, analyze data, and submit complete solutions and test results. This method helps to cultivate students' independent learning, problem analysis, teamwork and project management capabilities, enabling them to solve problems independently in actual projects.

(2) Hands-On Practice

The core of IoT communication technology lies in the interaction and data transmission between devices. The implementation of this process requires a lot of hands-on practice. Therefore, this course combines virtual simulation and physical equipment to provide students with rich practical opportunities.

Use simulation software such as MATLAB/Simulink and NS3 to simulate data transmission and communication protocol interaction in the AGV scheduling system, test the advantages and disadvantages of different communication technologies, and analyze their applicability.

Establish an Internet of Things laboratory, configure AGV models, sensors, communication modules and other equipment; let students build communication networks by themselves, such as configuring CAN bus nodes, debugging RS485 communications, setting WiFi hotspots, etc.; verify the performance of different communication technologies in actual environments through experiments, such as data transmission rate, signal stability and anti-interference ability. Through these practical links, students can intuitively understand the characteristics of communication technology, repeatedly optimize solutions in the experimental environment, and improve their ability to apply technology.

(3) Enterprise visits and case analysis

Combining theory with practice is an important principle of IoT teaching. Therefore, the course will arrange enterprise visits and case analysis to enable students to have a deep understanding of the application scenarios of communication technology in actual production, especially the actual operation of AGV scheduling system and the application of communication technology.

1) Company visits

Organize students to visit smart manufacturing enterprises, logistics centers, etc. to observe the actual operation of the AGV dispatching system. For example: visit smart factories and observe how AGVs are accurately positioned and dispatched in real time through WiFi; understand how AGVs in logistics centers are remotely controlled and tasked through WiFi; observe how smart warehousing systems use RFID technology for precise navigation to ensure that AGVs travel smoothly on complex paths.

2) Case Analysis

After the visit, students need to conduct case analysis based on the actual situation of the enterprise, for example: discuss the communication technology used in the enterprise's AGV dispatching system and its advantages and disadvantages, focusing on the application of WiFi, RFID and Bluetooth in the AGV system; propose optimization plans and conduct feasibility studies for the problems found during the visit; compare the AGV dispatching methods of different enterprises, and explore the development direction of communication technology for AGV dispatching systems in the future, especially in the context of the Internet of Things and Industry 4.0.

This approach can help students combine what they have learned in the classroom with real industry needs, cultivate their problem identification, analysis and innovation capabilities, and enhance their understanding of industry standards and cutting-edge technologies.

3.2 Teaching steps

3.2.1 Introduction phase

In the introduction phase, we first explain the basic concepts of IoT technology to help students establish an overall understanding of the field. The course content will include the definition of IoT, its composition architecture, and the basic knowledge of communication protocols. Through this theoretical foundation, students can have a clear understanding of the construction and operation principles of the IoT system.

In order to stimulate students' interest in IoT technology and motivation to learn, teachers will explain it with practical cases, such as campus power system and smart transportation system. In the campus power system, IoT technology is used to monitor power usage in real time, remotely manage power equipment, and improve energy efficiency. In the smart transportation system, IoT technology is used to monitor and manage traffic flow, optimize the distribution of traffic signals, and effectively alleviate traffic congestion. Through the display of these practical cases, students can more intuitively understand the importance and wide application of IoT technology in modern society, thereby stimulating their interest in learning this field.

3.2.2 Theoretical teaching

The theoretical teaching stage will explain in depth the working principles, characteristics and applicable scenarios of various communication technologies, with a focus on communication technologies such as CAN bus, WiFi, Bluetooth and RFID. By elaborating on the advantages and disadvantages of each technology and application scenarios, it will help students make reasonable technology choices in practical applications.

CAN bus: emphasizes its importance in industrial control, especially its stability and reliability when used to connect multiple devices, especially in the communication between various parts of the AGV vehicle.

WiFi: Suitable for local networks, has a high transmission rate, and is suitable for communication between AGVs and workshop equipment, especially in collaborative operations within workshops.

Bluetooth: Low-power, short-range communication technology, suitable for close-range interconnection between devices, and suitable for device connection and remote control operation in AGV vehicles.

RFID: Used to improve the positioning accuracy of AGV vehicles in complex paths, especially in precise navigation around turns.

5G: High-speed, low-latency communication technology, suitable for real-time data transmission in large-scale and complex environments, exploring its application potential in future AGV fleet management.

3.2.3 Practical teaching

In the practical teaching stage, students will be arranged to design and build a dispatching system based on a single AGV through a project-driven learning model. Students will be divided into groups to carry out project tasks, apply WiFi communication technology for dispatching and control, analyze the communication effect of WiFi in a single AGV, study how to use the CAN bus to improve the communication stability of various parts in the vehicle, and explore how to optimize the operation accuracy of AGV through laser navigation and RFID technology.

In this process, students will learn how to apply theoretical knowledge to practice. By using simulation tools such as MATLAB/Simulink, NS3, etc., students can simulate data transmission and communication protocol interaction in AGV dispatching systems, test the advantages and disadvantages of different communication technologies, and evaluate their feasibility in practical applications. Students will also use the virtual simulation environment to compare WiFi and CAN bus technologies and explore their application effects in a single AGV vehicle.

In addition, students are required to operate physical equipment, build an Internet of Things laboratory, and configure AGV models, sensors, communication modules and other equipment. In the experiment, students will build a WiFi communication network, configure CAN bus nodes, debug the connection between the sensors and communication modules in the AGV, and verify the performance of different communication technologies in actual environments, including data transmission rate, signal stability, anti-interference ability, etc. Through these practical links, students can have a deeper understanding of the characteristics of communication technology and improve their technical application capabilities in practice.

3.2.4 Enterprise visits and field research

Enterprise visits and field research are important links to combine theory with practice. By taking students to visit smart manufacturing enterprises, logistics centers, etc., students will have the opportunity to observe the application of a single AGV vehicle dispatching system in a real environment. For example, students can visit a smart factory and observe how AGV vehicles travel along magnetic strips and use RFID systems to accurately locate at corners. At the same time, students can understand how AGV vehicles communicate with stereoscopic warehouses, dispatch centers, etc. through WiFi to complete tasks in collaboration. Students can also see how AGV vehicles are manually controlled by remote controls and learn how the CAN bus ensures the coordination of various parts inside the vehicle body.

After the visit, students will conduct case analysis, discuss the communication technology and its advantages and disadvantages used in the dispatching system of a single AGV in the enterprise, and think about how to solve practical problems encountered in the enterprise by applying the learned technology. Students will focus on analyzing the application of WiFi communication technology in the AGV system, and propose optimization solutions for the AGV dispatching system, conduct feasibility analysis, and explore how to improve the efficiency and stability of communication technology, and further improve the collaboration ability, production efficiency and resource utilization of AGV vehicles in the workshop.

This teaching method that combines company visits with case analysis can help students closely integrate what they have learned in the classroom with the actual needs of the industry, enhance their practical ability and innovative thinking, improve their ability to solve practical problems, and lay a solid foundation for future employment or scientific research.

4. Results and Discussion

4.1 Experimental Content

According to the experimental requirements, students will design and implement a WiFi-based AGV remote control system, complete the integration of hardware and software, and ensure that the AGV can be stably remotely controlled and task scheduled via WiFi. Students will need to use a communication module (such as ESP32 or similar devices) to communicate with the AGV, and cooperate with the control algorithm to ensure the real-time response capability of the system.

4.2 Simulation and Experimental Verification

Based on the simulation and experimental results, students optimize the system to improve communication efficiency and stability. Students should propose innovative optimization solutions, such as adjusting hardware configuration, modifying communication protocols, or enhancing algorithm performance. Evaluation criteria include: innovation, design rationality, system stability, experimental data analysis, and optimization effect.

From the experimental data in Table 1, each group has different highlights in terms of the choice of control method and design innovation.

First, in terms of control method, groups 1, 3 and 5 use WiFi, while groups 2 and 4 choose Bluetooth. WiFi's high data transmission rate and wide range of applications make it a priority in the designs of multiple groups. In contrast, Bluetooth has unique advantages in low power consumption and anti-interference, and is suitable for applications in some special environments.

Table 1. Design of each group

Group Number	Control Method	Design Innovation
Group 1	WiFi	Introduced multi-level control algorithm to improve real-time performance
Group 2	Bluetooth	Combined Bluetooth low power and anti-interference technology
Group 3	WiFi	Increased communication coverage to solve weak signal issues
Group 4	Bluetooth	Developed adaptive scheduling algorithm to reduce interference
Group 5	WiFi	Used low-latency protocol to optimize signal transmission

In terms of design innovation, the innovative ideas of each group showed different technical advantages. Group 1 improves the real-time performance of the system by introducing a multi-level control algorithm, especially under high load and complex environments. Group 2 combines Bluetooth low power consumption and anti-interference technology to effectively improve the stability and energy efficiency of its system. Group 3 solves the problem of weak signals by improving the communication coverage, especially in a wide range of application scenarios. Group 4 develops an adaptive scheduling algorithm that effectively reduces signal interference, allowing the system to maintain good performance in different working environments. Group 5 significantly reduces control delays and improves the response speed of the system by using a low-latency protocol to optimize signal transmission.

In summary, each team closely integrates the actual application needs in the innovative design, improves the stability, real-time and efficiency of the system through different technical means, and reflects the diversity and pertinence of the design scheme.

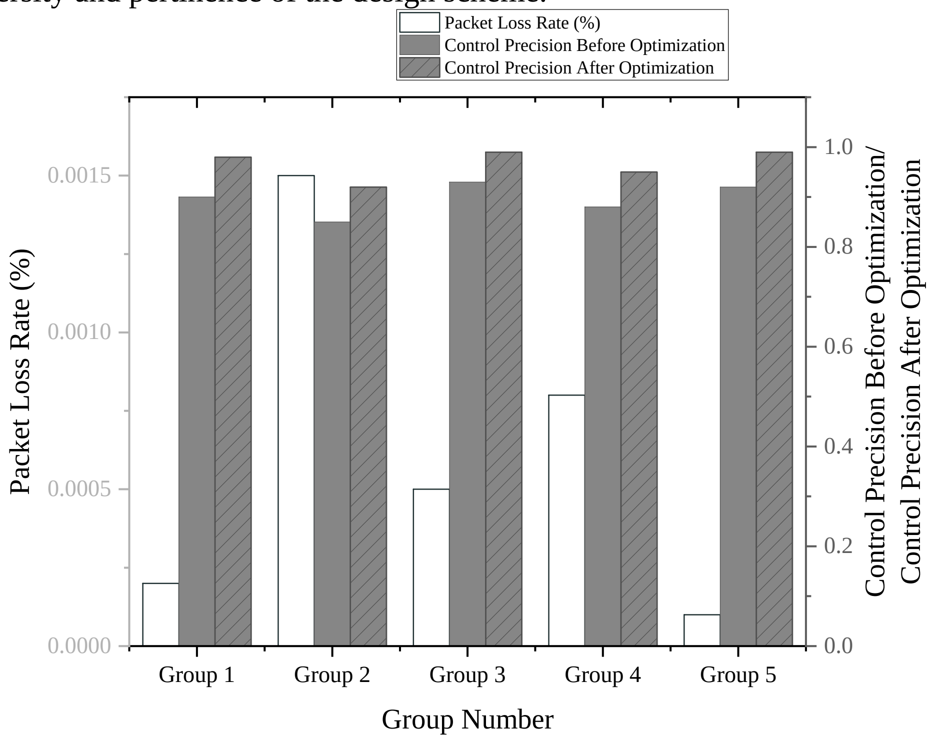

Figure 1. Evaluation of system optimization effect

From the experimental data in Figure 1, it can be seen that the communication systems of all groups performed very well in terms of packet loss rate. In particular, the packet loss rates of Group

1 and Group 5 are 0.02% and 0.01%, respectively, which are almost negligible, indicating that their communication networks are very stable. The packet loss rate of Group 2 is 0.15%, slightly higher than that of other groups, which may indicate that in some cases, there is slight signal interference or network instability during the transmission process, but it is still within an acceptable range overall. In terms of control accuracy, the control accuracy before optimization is generally high, with the lowest being 85% (Group 2). After optimization, the control accuracy of all groups is significantly improved, especially Group 1 and Group 5, which reach 98% and 99% after optimization, reflecting the significant improvement of system performance by optimization measures. The control accuracy of other groups also increase from about 90% before optimization to 92%-99%.

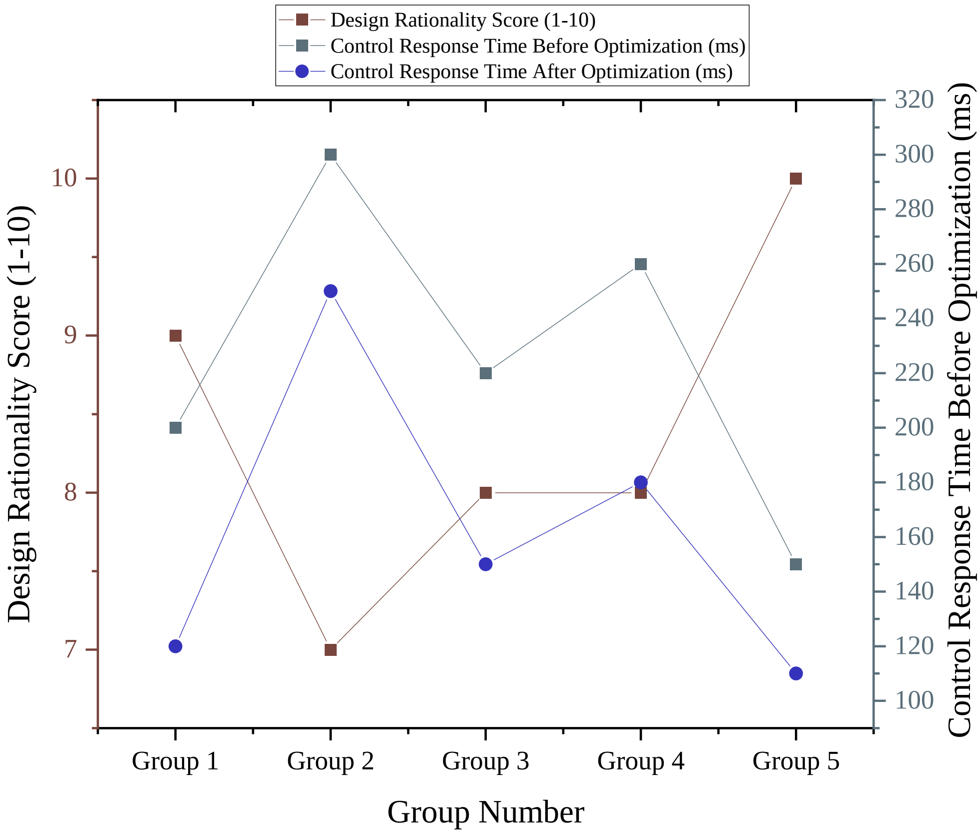

Figure 2. Design rationality and optimization process evaluation

In terms of design rationality, Group 5 receives the highest score of 10 points, indicating that its design scheme reaches the optimal level in terms of rationality and execution. The scores of other groups are generally high, indicating that each group pays attention to the feasibility and overall optimization of the system during the design process. Regarding the control response time, the time difference before optimization is large, with the shortest being 150ms (Group 5) and the longest being 300ms (Group 2). This reflects that there are some differences in the system response speed of each group in the early stage, especially Group 2, which has a longer response time. After optimization, the response time of all groups decrease, and the response time of Group 1 and Group 5 drop to 120ms and 110ms, respectively, with the most significant optimization effect. The response time of other groups also improve, ranging from 200ms to 250ms (as shown in Figure 2). The control response time of all groups after optimization has been significantly improved, indicating that the optimization measures have achieved positive results in improving the system response speed.

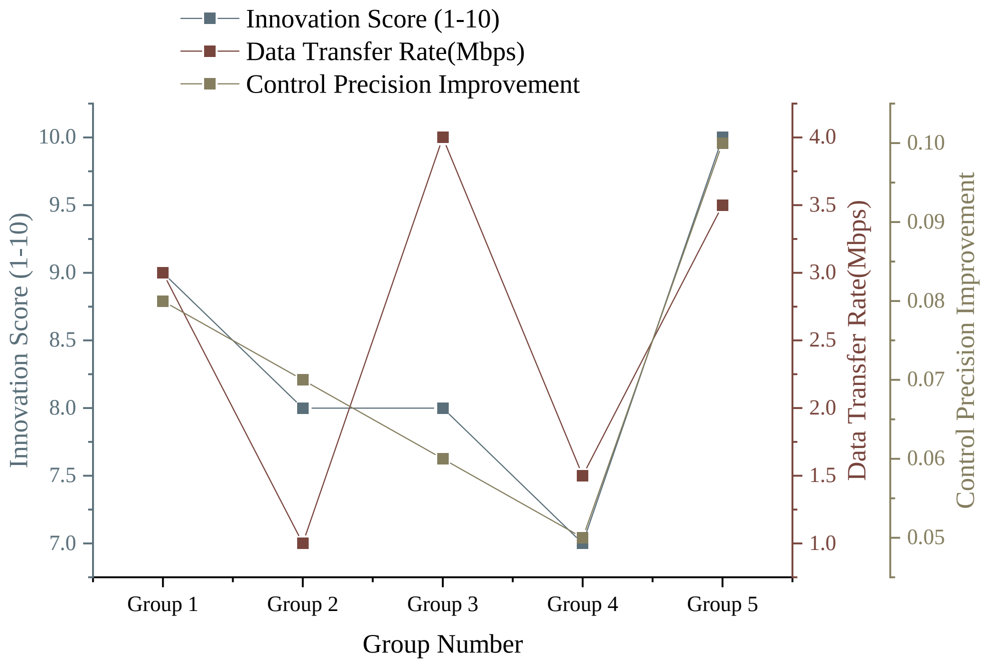

Figure 3. Innovation and experimental results feedback

All groups perform differently in terms of innovation, data transmission rate, and control accuracy. First, in terms of innovation, Group 5 receives the highest score of 10, indicating that it demonstrates strong innovation in the design and implementation process, especially in terms of improving control accuracy and data transmission rate. The innovation scores of other groups are generally high, indicating that each group incorporates innovative elements into the design of the solution. Secondly, in terms of data transmission rate, Group 3 has a rate of 4 Mbps, which is the best performance. The transmission rates of other groups are 3 Mbps (Group 1), 3.5 Mbps (Group 5), 1.5 Mbps (Group 4) and 1 Mbps (Group 2). Groups with higher rates show better results in achieving improved control accuracy. In particular, although the data transmission rates of Group 5 and Group 1 are different, their control accuracy has been significantly improved, reaching 10% and 8%, respectively. In terms of control accuracy improvement, Group 5 has the largest improvement in control accuracy, reaching 10%, indicating that its optimization measures have made the greatest contribution to improving system accuracy, as shown in Figure 3.

5. Conclusion

This study innovatively improves the teaching effect of IoT communication technology by introducing project-driven teaching methods and combining them with practical application scenarios, such as the design and optimization of AGV remote control systems. By comparing and analyzing the application and optimization of different communication technologies, students not only master the working principles of communication protocols such as CAN bus, Wi-Fi, and Bluetooth but also improve their ability to debug systems and optimize performance in actual experiments. The project-driven learning model encourages students to combine theoretical knowledge with practice, enhancing their ability to solve practical problems and their innovative thinking. The experimental results show that through carefully designed experimental tasks and practical links, students can continuously reflect and optimize the design during the execution of the project, improving the control accuracy and response speed. The optimized system not only shows significant improvements in control accuracy, data transmission rate and response time but also demonstrates the potential of different control technologies in IoT applications. However, this study also has certain limitations. Due to the limitation of experimental resources, students cannot achieve more complex communication environments and large-scale system scheduling during the experiment, so the universality of the experimental results may be affected. Future research can further improve the teaching effect by expanding the scale of experiments, adding more complex application scenarios, and enhancing students' practical training.

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References

[1] Badshah A, Ghani A, Daud A, et al. Towards smart education through internet of things: A survey[J]. ACM Computing Surveys, 2023, 56(2): 1-33.
[2] Silalahi L M, Simanjuntak I U V, Rochendi A D. Internet of Things Education Teaching and Learning Centre Harapan Bunda School Jakarta[J]. ABDIMAS: Jurnal Pengabdian Masyarakat, 2023, 6(4): 4439-4448.
[3] Meylani R. Transforming Education with the Internet of Things: A Journey into Smarter Learning Environments[J]. International Journal of Research in Education and Science, 2024, 10(1): 161-178.
[4] Gökçearslan Ş, Yildiz Durak H, Atman Uslu N. Acceptance of educational use of the Internet of Things (IoT) in the context of individual innovativeness and ICT competency of pre-service teachers[J]. Interactive Learning Environments, 2024, 32(2): 557-571.
[5] Srinivasulu M, Shivamurthy G, Venkataramana B. Quality of service aware energy efficient multipath routing protocol for internet of things using hybrid optimization algorithm[J]. Multimedia Tools and Applications, 2023, 82(17): 26829-26858.
[6] Alhasan A, Hussein M H, Audah L, et al. A case study to examine undergraduate students' intention to use internet of things (IoT) services in the smart classroom[J]. Education and Information Technologies, 2023, 28(8): 10459-10482.
[7] Alzahrani A. An analysis of the Technology Acceptance Model TAM in understanding Faculty's behavioral intention to use Internet of Things IOT[J]. IJERI: International Journal of Educational Research and Innovation, 2023 (19): 153-169.
[8] Mahariya S K, Kumar A, Singh R, et al. Smart campus 4.0: Digitalization of university campus with assimilation of industry 4.0 for innovation and sustainability[J]. J. Adv. Res. Appl. Sci. Eng. Technol, 2023, 32(1): 120-138.
[9] Akila D, Garg H, Pal S, et al. Research on recognition of students attention in offline classroom-based on deep learning[J]. Education and Information Technologies, 2024, 29(6): 6865-6893.
[10] Alhalangy A, AbdAlgane M. Exploring the impact of AI on the EFL context: A case study of Saudi universities[J]. Alhalangy, AGI, AbdAlgane, M.(2023). Exploring The Impact Of AI On The EFL Context: A Case Study Of Saudi Universities. Journal of Intercultural Communication, 2023, 23(2): 41-49.
[11] Hsiao H S, Chen J C, Chen J H, et al. A study on the effects of using gamification with the 6E model on high school students' computer programming self-efficacy, IoT knowledge, hands-on skills, and behavioral patterns[J]. Educational technology research and development, 2023, 71(4): 1821-1849.
[12] Yan L. A Low-Complexity Channel Estimation in Internet of Vehicles in Intelligent Transportation Systems for 5G Communication[J]. Journal of Organizational and End User Computing, 2023, 35(1): 1-21.