Training Project R&D of the Virtual Simulation Training Platform of Heating Engineering Operation & Regulation

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Abstract. To expand the R&D practical training projects relying on the virtual simulation training platform of heating engineering operation & regulation that has been built at present, which could not only meet the needs of colleges and universities and thermal enterprises to cultivate skilled talents in line with actual production needs, but also provide scientific research sites for university teachers. It ensure that fully expand the innovative application space of the platform, and better serve students, teachers and enterprise employees for learning and research.

Keywords: Training Platform, Training Project, Innovative Application

1. Introduction

The virtual simulation training platform of heating engineering operation & regulation is a practical training platform that simulates the actual process of heat network operation & regulation of central heating system, so that students can carry out actual operation training on operation & regulation and computer software.

2. Platform Architecture

The virtual simulation training platform of heating engineering operation & regulation consists of three parts: heating equipment operation & regulation reality system, virtual simulation system, 3D animation simulation scene system.

2.1. Reality System of Heating Equipment Operation & Regulation

The reality system of heating equipment operation & regulation includes three subsystems: experimental device that directly connect with central hot water heating system, experimental device that indirectly connect with central hot water heating system, and experimental device that indirectly connect (steam-water heat transfer) with central steam heating system.
The reality system of heating equipment operation & regulation takes the actual central heating heat network operation system as the prototype, transmits the data collected by the heating experimental device to the heating teaching-training detection control system, which can complete various tasks of the operation control process of the central heating system heat network, obtains the basic data from the system and writes the generated dynamic data into the database.

2.2. *Virtual Simulation System*

The virtual simulation system of heating operation is shown in Figure 1, which describes the experimental requirements and specific experimental contents of heating system operation, obtains the operation data from the database system to realize the presentation of the simulation process of heating network operation & regulation, obtains the experimental data by adjusting the operation parameters of heating equipment through the virtual simulation system, obtains the innovative experimental data by changing the design parameters of heating equipment, and can also maintain the basic data of the operation & regulation database in the virtual simulation system.

![Figure 1. Virtual simulation system](image)

2.3. *3D Animation Simulation Scene System*

The 3D animation simulation scene system is shown in Figure 2, which describes the teaching experimental method in heating teaching, the technological requirements for the operation of heating equipment and the parameter adjustment of operation & regulation. 3D animation, for it is more intuitive than the plan and possess the functions of systematic narration, music interpretation, text and water flow special effects, it can be browsed at any angle and present people with an immersive feeling. It is characterized by accuracy, high pictorial quality and authenticity.
3. Platform Training Projects

(1) Use the platform to simulate the working environment of actual heating enterprises, coupling with actual heating regulation cases from real engineering projects, students can simulate heating regulation skill training.

(2) Use the platform to set various operation parameters and adjustment conditions, freely simulate various adjustment methods in real projects, set various accidents and limit operation states, which enable students to carry out skill training for fault analysis and solution.

(3) Simulate the actual process of heat network operation & regulation of central heating system by using the platform, so that students can carry out operation training on actual operation & regulation and computer software.

(4) Simulate the actual operation environment of thermal enterprises by using the platform, automatically collect, store, count, calculate and analyze the optimal balance control scheme of the whole network under the current heat source output conditions, and determine the heat supply regulation parameters of the heat source and each heat transfer station [2]. Through comprehensive data analysis, the regulation and scheduling instructions for heating operation are issued to guide the stable and energy-saving operation of the whole network.

Table 1 is the actual operation record table of thermal company, and Table 2 is the result after the platform adopting the quality regulation principle [3] to regulate the actual operation of heat network. Through the comparison and analysis of the regulation results, it can be seen that under the condition of meeting the indoor temperature of 18 °C, it can save 2087.47 t one-week time coal consumption and 142113.2 kW.H power consumption to achieve the purpose of energy-saving operation. Therefore, the platform is used to regulate the operation of heating enterprises, and the pilot advantage of the platform for the operation of enterprises is fully reflected after energy conservation analysis and comparison.

Table 1. Record of actual operation of thermal company
| Heat source parameters                  | Monday, air temperature -10°C/-27°C | Tuesday, air temperature: -12°C/-27°C | Wednesday, air temperature: -14°C/-26°C | Thursday, air temperature: -14°C/-26°C | Friday, air temperature: -15°C/-28°C | Saturday, air temperature: -12°C/-23°C | Sunday, air temperature: -9°C/-19°C |
|----------------------------------------|-------------------------------------|----------------------------------------|------------------------------------------|----------------------------------------|----------------------------------------|----------------------------------------|----------------------------------------|
| Water supply/return temperature (°C)   | 88.1/47.8                           | 97.50.4                                | 105.52                                  | 105.7/51.6                             | 94/47                                  | 97/49                                  | 94.5/50.2                              |
| Water supply/return pressure (MPa)     | 0.52/0.31                           | 0.53/0.30                              | 0.65/0.29                               | 0.66/0.29                              | 0.57/0.31                              | 0.65/0.29                              | 0.64/0.3                               |
| Circulating water volume (t/h)         | 2947                                | 2890                                   | 2530                                     | 2450                                   | 2056                                   | 1960                                   | 2060                                   |
| Daily heat supply (GJ)                 | Load mw 148                         | Load mw 13069                          | Load mw 156                             | Load mw 13640                          | Load mw 13876                          | Load mw 154                            | Load mw 12743                          |
|                                        | Heat quantity 910                  | Heat quantity 929                      | Heat quantity 832                       | Heat quantity 764                      | Heat quantity 738                      | Heat quantity 720                      | Heat quantity 687                      |
| Daily coal consumption (t)             | 41680                               | 43240                                  | 41720                                    | 31480                                  | 46260                                  | 43260                                  | 37440                                  |

Table 2. Adjustment chart of platform operation
| Heat source parameters | Monday, air temperature -10°C/-27°C | Tuesday, air temperature: -12°C/-27°C | Wednesday, air temperature: -14°C/-26°C | Thursday, air temperature: -14°C/-26°C | Friday, air temperature: -15°C/-28°C | Saturday, air temperature: -12°C/-23°C | Sunday, air temperature: -9°C/-19°C |
|------------------------|-------------------------------------|---------------------------------------|----------------------------------------|----------------------------------------|-------------------------------------|--------------------------------------|------------------------------------------|
| Water supply/return temperature (°C) | 77.49/55.87 | 78.83/56.61 | 79.49/56.98 | 79.49/56.98 | 81.47/58.07 | 76.16/55.13 | 71.43/52.47 |
| Water supply/return pressure (MPa) | 0.52/0.31 | 0.53/0.30 | 0.65/0.29 | 0.66/0.29 | 0.57/0.31 | 0.65/0.29 | 0.64/0.3 |
| Circulating water volume (t/h) | 2947 | 2890 | 2530 | 2450 | 2056 | 1960 | 2060 |
| Load mw | Heat quantity | Load mw | Heat quantity | Load mw | Heat quantity | Load mw | Heat quantity | Load mw | Heat quantity | Load mw | Heat quantity |
|----------|----------------|----------|----------------|----------|----------------|----------|----------------|----------|----------------|----------|----------------|
| 72.2     | 6437.93       | 76.84    | 6786.07       | 70.67    | 6278.73       | 69.37    | 5688.84       | 63.05    | 5523.62       | 65.33    | 5399.51       |
| Load mw | Heat quantity | Load mw | Heat quantity | Load mw | Heat quantity | Load mw | Heat quantity | Load mw | Heat quantity | Load mw | Heat quantity |
| 575.95   | 599.35        | 492.31   | 457.49        | 492      | 473.68        | 401.75   | 3752.27       |
| Load mw | Heat quantity | Load mw | Heat quantity | Load mw | Heat quantity | Load mw | Heat quantity | Load mw | Heat quantity | Load mw | Heat quantity |
| 20432.37 | 20888.89     | 28625   | 13686.96      | 22565.85 | 21102.44      | 15665.27 | 3752.27       |

Daily coal consumption (t)
4. Expand R&D Training Projects

4.1. Restoring the Real Three Subsystem Technological Processes Using 3D Holographic Projection Technology

On the basis of the existing 3D animation simulation scene system, 3D holographic projection technology is further used to restore the real system. 3D holographic projection technology is a 3D technology without glasses, which can make students feel the whole heating process comprehensively, accurately and intuitively, and the specific location of various equipment, instruments and accessories.

4.2. Establishing 3D Digital Simulation Model

On the basis of the existing training facilities, 3D digital simulation modeling is transformed into 3D virtual training platform to make up for the lack of objective environment without training conditions, while enhancing students' stereoscopic tube understanding and learning interest.

4.3. Increasing the Application of AI Technology in the Platform

With the continuous development and progress of science and technology, the application field of augmented reality (AR) technology is more and more extensive. In educational teaching design, the application of mobile platform can help to carry out corresponding teaching activities in combination with teaching characteristics on the basis of effectively improving teaching quality, so as to construct a more efficient classroom system [1].

On the basis of the existing training facilities, it is recommended to further promote the development of AR technology application, truly use AR technology to "seamlessly" connect the real heating system and the virtual system, furthermore, apply the real heating system to the real operation that is difficult to experience due to the influence of time and space, such as equipment, pipeline installation, demolition and other construction operations. Simulating and then superposing through computer and other science and technology to apply the virtual installation information process to the real environment, therefore, students can use sensory perception to achieve a more profound learning purpose.

4.4. Development of Scientific Research Projects

Considering the construction scale of the training room, the measured demonstration data in the training are inconsistent with the theoretical calculated values. It is needed to upgrade R & D training platform and to ensure automatically checking of the measured data results in the training, and then, to display the correct theoretical calculation values. Teachers can use the platform for scientific research in combination with the actual operation effect of enterprises to better serve the society.

5. Conclusion

The full development of the practical training project of the virtual imitation real training platform for the heating engineering operation & regulation enables students to fully understand their own knowledge of heating regulation and combine theory with practice. It enhances students' understanding of professional technology, and greatly improves practical ability, research ability, innovation ability and comprehensive quality. Besides, enterprises can make full use of the platform for the operation & regulation of heat network to analyze the optimal balance control scheme for the whole network operation, and determine the optimal heating regulation parameters. In terms of university teachers, they can conduct in-depth scientific research, timely theoretical analysis, and solve the existing problems in the operation. The platform is with outstanding application role with fully develope function and more extreme results exerted.
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