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Application of Artificial Intelligence Teaching Assistant to Assist Students in Exploring S-shaped Pipeline Science in the Course of Fundamentals of Mechanical and Electrical System Control

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Abstract: This paper focuses on the pain points in the teaching of the course "Fundamentals of Mechanical and Electrical System Control", and explores the application path and effectiveness of artificial intelligence teaching assistants in assisting students in carrying out scientific exploration and practice of S-shaped pipelines. The research shows that the artificial intelligence teaching assistant realizes the accurate matching and instant Q&A of course knowledge points through the construction of knowledge graphs, and generates personalized learning paths with the help of machine learning algorithms, which effectively solves the problem of insufficient guidance in traditional teaching. In the exploration practice of S-shaped pipelines, the dynamic visual display, real-time fault diagnosis feedback and multi-dimensional evaluation system of the intelligent simulation platform have significantly improved students' ability to apply core knowledge such as path planning algorithms and motor control principles. The practical results show that this teaching mode not only reduces the teaching burden of teachers, but also cultivates students' engineering practice literacy and innovative thinking, and provides practical experience for the intelligent teaching reform of engineering courses.

Keywords: artificial intelligence teaching assistant; electromechanical system control; S-pipeline exploration; teaching practice; Intelligent teaching of engineering

1 INTRODUCTION

As a core course of multidisciplinary integration, "Fundamentals of Mechanical and Electrical System Control" faces problems such as theoretical abstraction, high practical threshold, and large differences among students in teaching. In the traditional model, it is difficult for teachers to take into account the individual needs of each student, especially in the design and debugging of complex control systems, and students often fall into inefficient trial and error due to the lack of real-time feedback. The introduction of artificial intelligence teaching assistants can effectively solve these dilemmas: its knowledge graph Q&A system can achieve accurate matching and real-time explanation of knowledge points, making up for the limitations of classroom teaching; By analyzing learning behavior data, personalized learning paths can be dynamically generated to help students break through key and difficult points. In the virtual simulation experiment, it can simulate the changes of parameters under real working conditions, provide students with a safe and efficient practice environment, significantly improve the pertinence and effectiveness of teaching, and become an important support for curriculum teaching reform.

S-type pipes are actually a type of trap that allows sewage to flow out of the room and prevents odors and other gases from entering the room. The trap trap creates a seal that prevents sewer gases from entering through the drain. After filling the same liquid into the communicator, when the liquid is at rest, the

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liquid level is always flush, and this principle is called the communicator principle [3-5]. Based on the principle of connector, in the S-type pipeline, the pressure on the liquid level at the same level is equal, and the pressure on the liquid surface is equal to the atmospheric pressure, so the liquid level is the same. When there is sewage on the inlet side, the liquid level pressure on the inlet side is high (atmospheric pressure plus sewage pressure), so that sewage can flow out. When the sewage is finished, the liquid pressure on the inlet and outlet sides is equal to the atmospheric pressure, so the liquid level is equal. At the U-shape of the tube, the liquid level is level. In this way, the last bit of sewage separates the pool and the sewer, which plays a role in preventing the odor of the sewer from returning [6]. Moreover, there are times when large debris entering the water inlet can be left in the U-shaped pipe to prevent sewer blockage.

As a typical practical project, S-shaped pipeline exploration involves path planning, motor control, sensor fusion and other technologies, and has high requirements for comprehensive capabilities. Artificial intelligence teaching assistants provide precise assistance through multiple ways: build a virtual simulation platform to restore the pipeline structure based on 3D modeling, simulate fluid motion or robotic arm trajectory in real time, and visualize key data such as pressure and speed to help students intuitively understand the characteristics of the system. Construct an intelligent guidance module, use reinforcement learning to analyze common problems, push similar case schemes when there is a deviation in the control strategy, reveal the causes through data comparison, and guide the optimization of PID parameters or path algorithms. Establish a practical evaluation system, collect debugging records and troubleshooting data, use multi-dimensional models to generate evaluation reports, provide objective process feedback, and provide data support for teachers to improve teaching plans, effectively improving the quality of practical teaching.

2 Experimental Simulation

2.1 Establishment of S-Type Pipeline Model Based on SW

This project takes the S pipeline as the research object to simulate the flow process of pipeline water flow and know the water sealing principle of the pipeline according to the principle of connector. The water flow enters from the inlet and flows out from the outlet, simulating the flow law of its water flow in the pipeline. In this process, the flow rate of each part of the pipeline can be obtained, so as to judge whether the pipeline has water sealing properties and whether it can isolate odors. The relevant structural parameters of the S pipeline are shown in Table 1.

Table 1 Pipeline Structure Parameters

name	size
Pipe diameter	2.5cm
Corner angle	90 °
Intermediate tube length	30cm
Length of tubes on both sides	20cm

First, the model is established in the SW software, as shown in Figure 1, and then transferred to Fluent for simulation analysis.

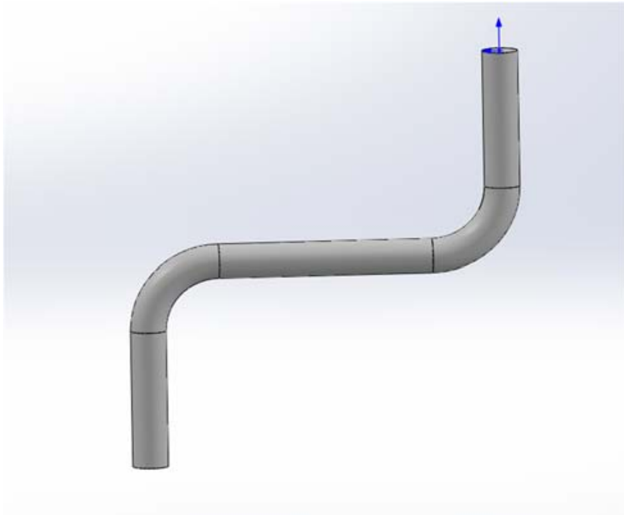

Fig. 1 S-Pipe Model

2.2 Import the S-Pipeline Model

To simulate the fluid in the pipeline, we use the Workbench module, first drag the fluent flow (fluent) into the workspace, click Geometry to import the built model, and set its format to x_t. Then the pipeline is extracted from the fluid and the shell is removed, and finally the mesh is opened for meshing, as shown in Figure 2, and then the mesh size is adjusted to encrypt the mesh.

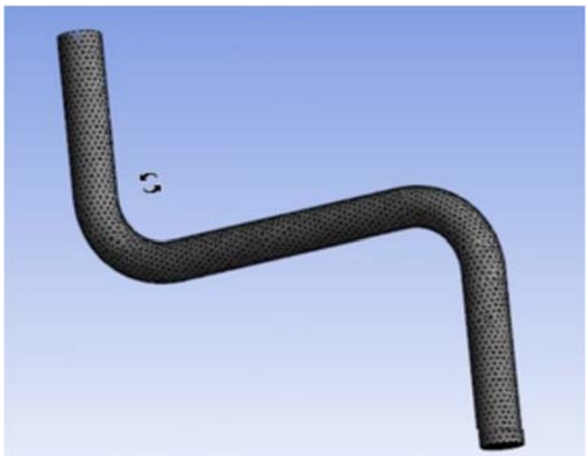

Fig.2 Grid Division of S Pipes

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Next, toggle the boundary selection and set the boundary conditions (entrance, exit, wall), the entrance is named inlet, the exit is named outlet, and the wall is named wall.

2.3 Simulation Results

The temperature distribution and trace distribution of the fluid in the pipeline are shown in Fig. 3 and Fig. 4.

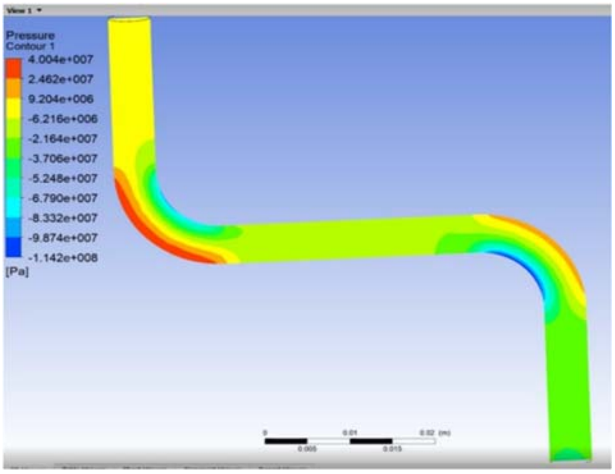

FIG.3 TEMPERATURE DISTRIBUTION CHART

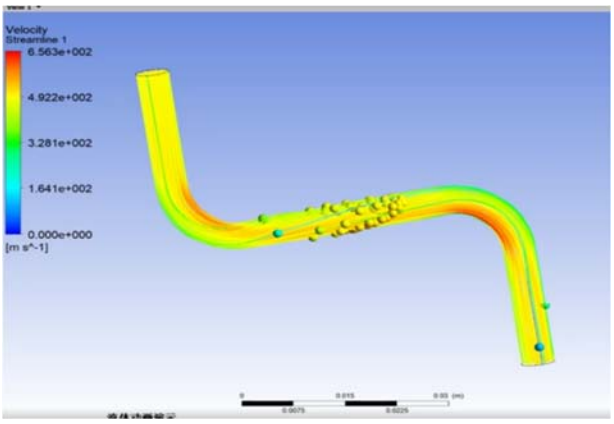

FIG. 4 TRACE DISTRIBUTION MAP

3 Simulation Result Analysis

From the temperature distribution diagram and trace diagram, it can be seen that the temperature distribution at the right angle of the S pipeline is higher, the flow rate is faster, and the temperature of the two ports is basically the same, and the flow rate is basically the same, which is basically the same as the flow rate and temperature of the pipeline in the middle part, indicating that the pressure of the fluid at the pipeline is larger, the faster the flow rate, the flow rate of the two ports and the middle part of the pipeline is basically the same, in line with the principle of the connector, indicating that the S pipeline can play a role in water sealing, can block odors, and there is also a risk of staying large items. Therefore, the pipeline needs to be cleaned and dredged frequently. As shown in Fig. 5, the residual plot of the pipeline fluid velocity is simulated, and when all the variables are reduced to 1e-3, the computational convergence is considered to be calculated, and the residual convergence of the simulation operation is obtained.

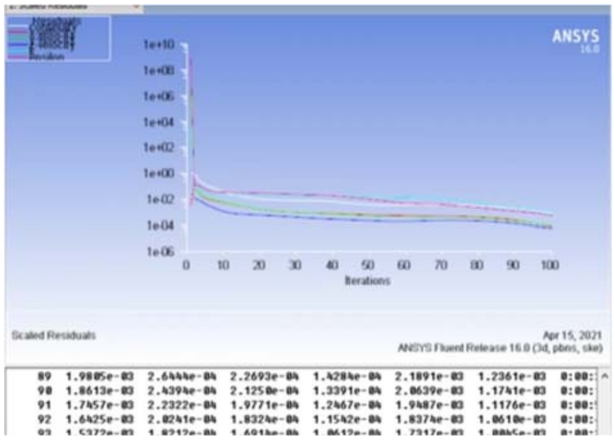

FIG. 5 RESIDUAL PLOT

As shown in Figure 6, it can be seen that the velocity of the fluid decreases after entering the pipeline inlet, gradually increases when passing the corner, and changes and decreases again when it reaches the second corner, until the velocity at the outlet is basically the same as the velocity at the inlet, which is in line with the working principle of the connector.

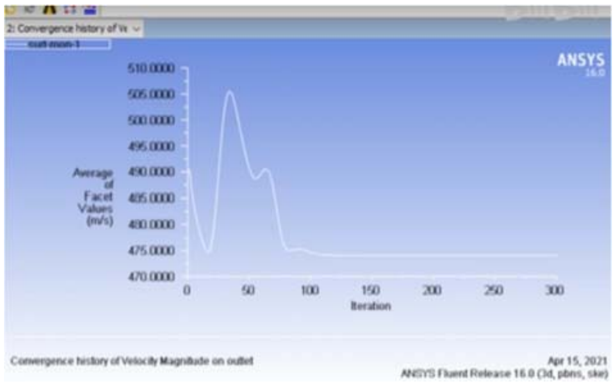

FIG.6 VELOCITY CHANGE DIAGRAM OF FLUID PARTICLES

4 Conclusion

In the course of "Fundamentals of Mechanical and Electrical System Control", artificial intelligence teaching assistants are introduced to assist in the scientific exploration and practice of S-shaped pipelines, which effectively realizes the innovation of teaching mode and the improvement of teaching quality. From the perspective of application value, artificial intelligence teaching assistants accurately solve the problems of difficult theoretical abstraction and insufficient practical guidance in traditional teaching through knowledge graph Q&A, personalized path planning and virtual simulation training, which not only reduces the teaching burden of teachers, but also meets the differentiated learning needs of students, making the design and debugging process of complex control systems easier to operate and more targeted.

In terms of practical results, in the exploration of S-shaped pipelines, the dynamic visual display of the intelligent simulation platform, the real-time feedback of problem diagnosis, and the construction of a multi-dimensional evaluation system have significantly improved students' ability to apply core knowledge such as path planning algorithms and motor control principles, and cultivated their comprehensive literacy in analyzing and solving problems. In the future, with the continuous development of artificial intelligence technology, further optimizing the independent learning ability and scenario adaptability of the teaching assistant system will provide stronger support for the practical teaching of mechanical and electrical courses, and promote engineering education to continue to move towards intelligence and precision.

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