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Exploration and Practice of Virtual Practice Teaching in Electromechanical and Hydraulic Integration Course

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Abstract

The specialized courses covered by mechanical and electronic engineering major are all required courses with high comprehensiveness and strong practicality. However, the traditional course teaching mostly emphasizes the explanation of theoretical knowledge and weakens the cultivation of students' practical ability. Based on years of teaching accumulation and feedback, practical teaching is explored from the aspects of adjusting experimental period and content, combining virtual-real practice and discipline competition, etc. With the help of various simulations, virtual experiment system is built, and comprehensive practical ability, engineering application ability and innovation ability of students are cultivated in-depth and comprehensively.

Keywords

Electromechanical Hydraulic Integration; Practical Teaching; Virtual Simulation Experiment.

1. Introduction

Practice is an important part of higher education in cultivating students' practical ability and innovation ability, and is an important content of higher education teaching reform. Especially in application-oriented universities, practice teaching plays a decisive role in carrying out quality education and cultivating students' comprehensive application ability. Under the virtual simulation teaching mode, learning scenarios and operation procedures will be presented one by one, and will be designed and verified in the actual operation process, in order to realize the effective combination of theory and practice. In addition, being flexible and efficient, virtual simulation teaching is not only conducive to the development of personalized teaching attempts, but also in line with the development of experimental teaching mode in many application-oriented universities.

The main motivation of this paper is to innovate the virtual simulation technology into the experimental teaching of the key courses of mechanical and electronic engineering, such as "Fundamentals of Mechanical Engineering Control", "Sensor Principle and its Application" and "Hydraulic and Pneumatic Technology". The three key courses are thoroughly analyzed, especially the main teaching situation and teaching methods designed in "Fundamentals of Mechanical Engineering Control". And a more reasonable teaching plan is obtained combined with the specific teaching process and teaching effect.

2. The Application of Virtual Simulation Technology in the Teaching of "Mechanical Engineering Control Foundation"

As a core course related to mechanical electronics, "Fundamentals of Mechanical Engineering Control" has certain requirements for students' comprehensive ability. Before learning the course, it is necessary to have a certain understanding of partial differential equations, Laplace transform and Fourier transform, which is difficult for students to understand theoretically.

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Based on the preliminary study of mechanical transmission principle, sensor principle and motor drive related principle, the transmission process of physical signal of electromechanical system is deeply understood through the understanding of the virtual simulation model of specific application examples. Meanwhile, students can have a sense of achievement in the practice process and use it as a driving force to enhance the understanding of theoretical knowledge.

The practice of "Mechanical Engineering Control Foundation" varies in the way and type in each school. The representative topics are "Time Domain Analysis of Control System", "Frequency Domain Analysis of Control System", "SIMULINK Mechanical Vibration System Dynamic Simulation", etc. The practice based on the virtual simulation teaching platform is to simulate the experimental equipment into a specific electromechanical system. Therefore, the course design is closely related to the actual system. The main tasks to be completed in the design room are electromechanical dynamic system principle design, electromechanical dynamic system SIMULINK modeling, system parameter setting, related module selection, result analysis, design summary, etc. In order to complete the tasks of electromechanical dynamic system composition, parameter setting, system simulation debugging and fault diagnosis, "SIMULINK mechanical vibration system dynamic simulation" is used as the course design topic to explain the design process and its requirements.

2.1. He Establishment of Mechanical Forced Vibration SIMULINK Simulation Model

Combined with the analysis of damping element, elastic element and inertia element in mechanical vibration, the second-order partial differential equation can be established for the physical signal transmission process of mechanical vibration system and the relevant parameters can be calculated based on the speed input and load resistance. Then students need to enter the MATLAB SIMULINK virtual simulation platform, get familiar with the operation of relevant modules and build the SIMULINK model. It not only enables students to have basic design ability, but also strengthens the training of students" specific application of theoretical knowledge to build simulation model.

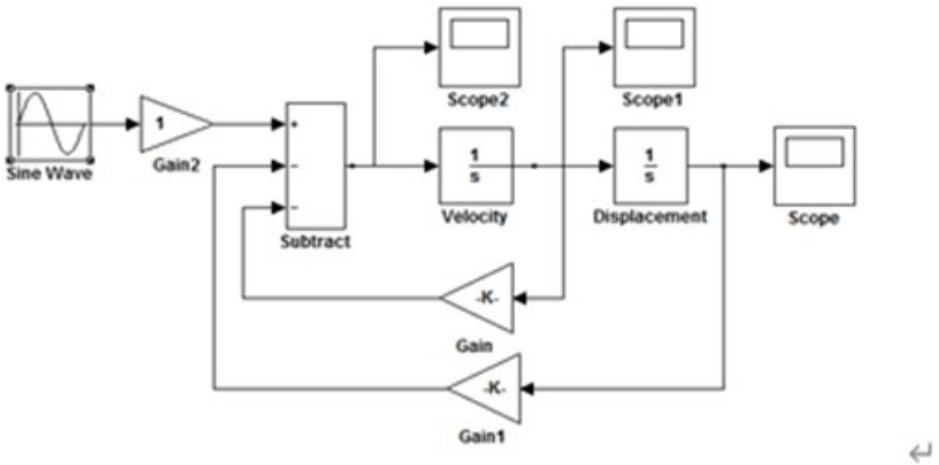

Fig. 1 Flow chart of forced mechanical vibration simulation

2.2. Macroscopic Simulation of the Simulation Model from the Energy Point of View

According to the formula of kinetic energy and potential energy, the Product module which implements the operation of $\vec{x}^2$ and $\vec{v}^2$, the Gain module and Sum module are added to the initial forced vibration simulation flow chart to superimpose the two input signals to output the

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kinetic energy, potential energy and mechanical energy wave forms.) The added modules and their properties are set as follows:

1) Add two Product modules under the Math Operations module library, and set its Number of inputs attribute to 2.

2) Add two gain modules Gain3 and Gain4 to the Math Operations module library, which represent the coefficients before the displacement squared term and the velocity squared term, respectively.

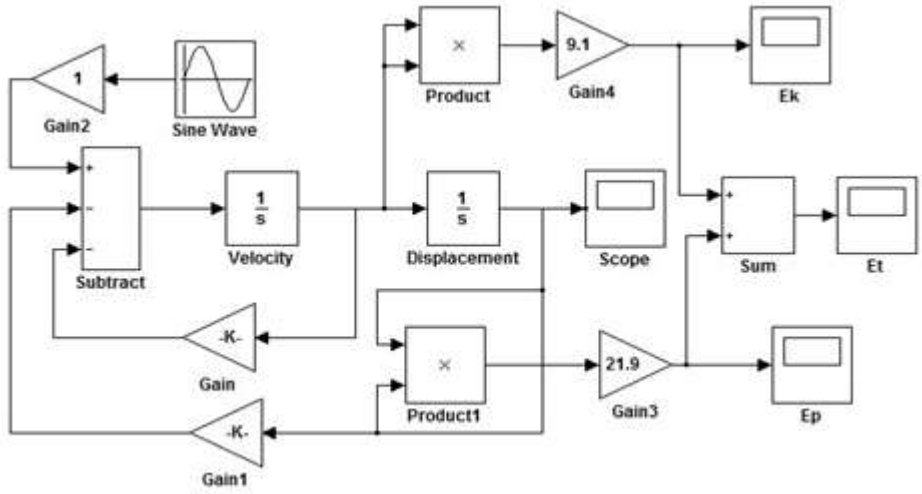

Fig. 2 Flow chart of forced mechanical vibration simulation energy field simulation

Through the specific example, it can help students to understand the "time domain analysis of control system" more deeply and can be extended to the analysis of electromechanical and hydraulic integrated system.

3. The Application of Virtual Simulation Technology in the Teaching of "Hydraulic and Pneumatic Technology"

AMEsim is a widely used simulation software in hydraulic pneumatic system. It is easy to carry out joint simulation analysis with MATLAB/ SImulink and ADAMS. Although it has good versatility, the degree of localization of AMEsim is rather low. As a tool for hydraulic field engineers to carry out mainstream simulation of hydraulic systems, it has relatively high requirements for the engineers' capabilities and may be difficult for students to learn. However, it is very beginner-friendly to use the Festo's FluidSIM-H/ FluidSIM-P and the new hydraulic simulation toolbox Simhydraulics integrated by the general mathematics MATLAB and SIMULINK. Therefore, they are widely applied in the hydraulic and pneumatic teaching simulation practice teaching links. It can further encourage students to use AMEsim in practical teaching and do a good job in joint simulation, so as to deepen the macro understanding process of the whole professional system of mechanical manufacturing automation and mechatronics.

4. The Application of Virtual Simulation Technology in the Teaching of "Sensor Principle and Application" Course

The main software used in the teaching of "Sensor Principle and Application" course is LabVIEW. As a standard data acquisition and instrument control software, LabVIEW integrates all the functions of communication with hardware and data acquisition card that meet GPIB, VXI, RS-232 and RS-485 protocols. It also has built-in library functions to facilitate the

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application of TCP / IP, ActiveX and other software standards. It can be easily used to establish its own virtual instrument and its graphical interface makes the programming and use process very lively and interesting. The simulation of eddy current, Hall, photoelectric, thermoelectric sensor principle and conversion circuit can clearly visualize the experimental process. The comparison of virtual simulation experimental results and actual experimental results will help students understand the experimental process and effectively reduce the loss of actual experimental electronic components.

5. Conclusion

When organizing the teaching content of the core courses of mechanical electronics, the teaching, practice and operation processes suitable for students' learning can be designed according to the latest technology of this major combined with the current needs of enterprises and the help virtual simulation platform technology. Based on the effective use of laboratory experimental hardware equipment, the virtual simulation technology can be applied step by step to the practical teaching of the key courses of mechanical electronics. And a virtual simulation experiment teaching mode suitable for different courses can be created so that students can have a sense of participation and acquisition in the learning process and effectively improve the teaching effect.

Acknowledgments

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