Research and Practice of Simulation Technology in Engineering Specialized Course Teaching

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Abstract: This paper describes some methods used in our classroom teaching, by means of which students have increased their studying passion, and the effect of teaching was improved. We use Flash animation to demonstrate the relation dynamically between the load, speed, voltage, current, and the transition process step by step, use MultiSim to observe and analyze the signal changes in any link, by adding oscilloscope components in different places, use MATLAB/SIMULINK to simulate and analyze the dynamic characteristics of the designed control system, based on the established mathematical model of each link in the control system. Through all these means students can understand and master the abstract theory and the key link of the motion control system conveniently as well as teachers can make more efficient use of class time.

Introduction

"Computer control system" and "electric drive control system" are the main courses for automation major and electrical engineering major. Both these two projects are also the key courses that train automation major students to integrate theory with practice. However, we teachers are faced with many difficulties in the teaching process, such as there is much course content, but less class time, furthermore, the "computer control system" and "electric drive control system" courses are boring, abstract, which is difficult for the students to understand. For this reason, how to make students understand the abstract teaching content more quickly, how to make the class atmosphere lively and interesting and achieve the goal of teaching at the same time, are the problems which a specialized course teacher faces.

Computer simulation technology has a wide range of performance capabilities, can go beyond the macro and micro constraints, to provide students with a wealth of perceptual materials, the teaching ideas and teaching links are fully reflected in the classroom teaching. It expresses the teaching content concretely, reflects the inherent law of things, and provides a wealth of perceptual experience and thinking materials for students' cognitive activities, which is conducive to learn and master knowledge for students[1]. According to the characteristics of modern education technology and the feedback in practice teaching, this paper puts forward the introduction of simulation technology into the teaching of motion control system, which can be regarded as an effective modern educational means.

Using simulation technology is to imitate the real system, which is an important means and method to analyze and study the system motion behaviors, revealing the dynamic process and motion law of the system based on the physical system of the actual system[2]. Simulation technology can reproduce the process of the occurrence and development of things vividly, so that the imperceptible can clearly appear in the range of students' perceived ability. It can turn abstract into concrete, static into dynamic, microscopic processes into macro simulations, so as to overcome the limitations of human senses, expand the students' cognitive space, shorten the cognitive process, reduce learning difficulty, and achieve the effect of breaking through the teaching difficulties ultimately. The use of simulation technology can make the teaching become vivid, and the problem
of abstract thinking disorder, logical thinking obstacle and language expression disorder can be solved to a large extent by showing the essence of a problem quantitatively with charts. Therefore, it is necessary to introduce computer simulation technology into the course teaching of control system.

This paper mainly discusses the application of Flash, MultiSim and MATLAB/SIMULINK simulation platform in the course projects of "computer control system" and "electrical drive control system".

**Simulation Technology Based on FLASH Animation**

Flash is an excellent web animation design software launched by the United States company MACROMEDIA. It is a kind of interactive animation design tool, which can fuse music, sound effect, animation and innovative interface together, in order to produce high quality dynamic demonstration effect[3]. Making animation courseware by Flash can provide students with a colorful, vivid, friendly, convenient and flexible simulation interface, so that the students can receive the teaching information at the same time, understand the process details of the control system easily.

For example, when talking about the double closed loop DC speed regulation system, the analysis of the starting process, students have been difficult to understand and absorb. When the voltage of the double closed-loop control system starts suddenly from the stationary state, the speed regulator ASR undergoes three stages of unsaturated, saturated and retrograde saturation during the starting process, and the whole transition process is divided into three stages (as shown in Fig. 1): I forced flow stage, II constant flow speed up stage and III speed regulation stage. The speed and current double closed-loop speed control system uses the saturation nonlinearity of speed regulator ASR subtly in the step given of starting process, makes the system become a constant current control system. After the ASR is desaturated, the system achieves stable operation, and it behaves as a speed regulation system without speed static difference.

![Figure 1. Starting Process of DC Double Closed Loop Speed Regulating System.](image-url)
Using Flash animation to demonstrate the relation dynamically between the load, speed, voltage, current, and the transition process step by step, so that students can accept the content easily which is difficult to understand, abstract or obscure, reduce the difficulty of explaining the theory, compensate for the negative effects caused by the lack of experimental or non-synchronous between them.

**Simulation Technology Based on MultiSim for Analog Circuits**

Multisim is a Windows based simulation tool launched by Interactive Image Technologies (Electronics Workbench) company. It is suitable for the design work of analog/digital circuit board in board-level. It contains graphical input of circuit principle diagram and input mode of circuit hardware description language, and has rich simulation and analysis ability.[4]. MultiSim is an excellent electronic circuit simulation software, it provides tens of thousands of components, power and instrumentation, as well as more than a dozen circuit analysis methods, so that you can simulate the circuit environment and circuit process, but don't have to worry about the damage of equipment owing to the accurate and reliable results. It can be used in teaching and experiment, which can break through the traditional teaching mode, make the students feel the real state of the dynamic and static state of the circuit, visualize the abstract content, and can improve the learning interest and analysis ability of students as well as the teaching effect.

![Figure 2. Double Closed Loop DC Speed Regulating System.](image2)

![Figure 3. Simulation of DC Double Closed Loop Speed Regulating System Based on MultiSim.](image3)
At present, most of the reference materials of motion control system are based on analog circuit design, so the the structure of control system can be modeled and simulated directly according to the textbook by the using of MultiSim software, the main work to do is just to adjust the parameters of electrical components. For example, double closed-loop DC speed control system (see Fig. 2), it is convenient to build the simulated control system in MultiSim environment, as shown in Fig. 3. We can observe and analyze the signal changes in any link, by adding oscilloscope components in different places where we need, and increase students' understanding and mastery of abstract theory and content.

**Simulation Technology Based on MATLAB/SIMULINK for Mathematical Model**

SIMULINK is one of the most important components of MATLAB. It provides an integrated environment for modeling, simulation and analysis of dynamic systems. In this environment, a complex system can be constructed by simply and intuitively mouse manipulation without the need to write a large number of programs. SIMULINK has many advantages, such as wide adaptation, clear structure and process, fine simulation, close to reality, high efficiency and flexibility. Based on the above advantages, SIMULINK has been widely used in complex simulation and design of control theory and digital signal processing[5].

We should abstract the mathematical model of each link in the control system when we design a system even if it is simulated. Then we design the control system, mainly the controller, according to the requirements of the control system performance indicators. In addition, motion control system in modern industrial field has been transferred to digital control gradually, it is should be focused on the design of digital controller. Therefore, based on the established mathematical model of each link in the control system, directly with the transfer form, the mathematical model of function, on the basis of the control diagram of the motion control system, we can simulate and analyze the dynamic characteristics of the designed control system in MATLAB/SIMULINK environment. Fig. 4 is a simulation of double closed loop DC speed regulation system based on transfer function. Fig. 5 is the simulation result of current and speed.

After the simulation system is established, the transition curve of the system speed, current and so on can be simulated and analyzed under different conditions, such as sudden addition step, sudden increase step disturbance, feedback line disconnection, saturation limit size and so on, further understand and grasp the dynamic characteristics and adjustment methods of each link in the motion control system, cultivate and develop students' independent thinking and creative ability.
Figure 5. Simulation of Current and Speed of DC Double Closed Loop Speed Regulation System Based on MATLAB/SIMULINK.

Conclusion

By introducing the simulation technology into the classroom teaching of "computer control system" and "electric drive control system", the contents which are difficult to understand in the teaching process are expressed by animation and simulation, so that the abstract content is materialized, and the key links are visualized. Teachers can fully convey the teaching intention in the classroom, reduce classroom teaching pressure, increase teaching capacity, and promote students to obtain more knowledge in limited time, and achieve ideal teaching effect.

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