Design of Motor and Drag Virtual Simulation Practice Platform Based on MATLAB GUI

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Abstract

The virtual simulation platform of the motor and driving course is established by using MATLAB Graphical User Interface (GUI), and the corresponding simulation model is based by using the core knowledge and practice theory related to the course. With the integration and decomposition of actual engineering projects as the line, the virtual-real collaborative teaching courseware and experiment platform based on the Conceive-Design-Implement-Operate (CDIO) concept is developed. The "experimental platform mode" experiment of a single scattered knowledge point is extended to the experimental platform throughout the project case, and the practical mode of "verification," "research," "comprehensive ," and "independent design" gradually transition from point to surface to body has enriched the content and means of experimental teaching. To promote teaching to simplify its abstract, obscure formula derivation and complex process, assist students in understanding, stimulate students' enthusiasm and exploration, cultivate engineering awareness and improve practical ability. Realize the integration of teaching and virtual and real cooperation.

Keywords

MATLAB, Graphical User Interface, Teaching platform.

1. Introduction

With the explosion of concepts related to the "industrial metauniverse", the idea is more like the future form of intelligent manufacturing; the idea of virtual-real collaboration is a means to promote the virtual space and the actual space. As an automation major, to cultivate students' technological concept of artificial intelligence and futuristic thinking of virtual and real cooperation, the development of an online simulation teaching platform can effectively connect relevant ideas, considering that the automation major has the characteristics of multi-disciplinary crossing and strong combination of theory and practice.

With the diversification of social development and due to the rampant spread of the epidemic in recent years, traditional teaching cannot be carried out normally, network teaching has become an essential means of teaching so as to carry out the design of online teaching platforms, which is more in line with the characteristics of the digital age, convenient for students to run on the web page, to achieve convenience and interconnection.

At present, in the practical classes of motor and motion control in colleges and universities, the teacher basically explains the experiment principle and demonstrates the operation steps. Students imitate the experiment operation, measure and record the data and write the experiment report in groups. This teaching form is too simple, and the experiment operation, report and attendance rate in proportion mainly evaluate students' experiment results. This cannot objectively reflect each student's practical ability and innovation ability in practical

engineering. Students can also not connect various links in a simple closed-loop control system and lack engineering concepts.

Given the above problems, this paper establishes a teaching simulation platform to assist students in using Simulink and GUI interface to feel the corresponding simulation model intuitively, understand the motor starting, speed regulation, braking and other related principles, improve students' hands-on ability and theoretical knowledge. Promote better teaching quality, make up for the deficiency of traditional teaching, make students effectively grasp the corresponding knowledge reserves and technical literacy, awaken their spirit of innovation and ability, and better train the required technical talents in line with the practice.

2. Composition and Design of Simulation Teaching Experiment Platform

2.1. The design idea of simulation teaching platform

The virtual simulation platform can demonstrate the teaching mode from simple to complex, single to integrated and multi-wing without time and space restrictions so as to achieve an immersive, open, independent and interactive virtual environment, students can efficiently carry out economic and safe experimental projects and improve the teaching effect that is difficult to achieve in traditional practical teaching. Cultivate students' independent learning ability and innovative thinking instead of immobilizing students and teachers in the laboratory to explain.

At the same time, on the platform, middle school students can use the established circuit simulation to draw the measurement graphics of experimental data and process the data, which plays a positive role in mastering the practical principles and methods [1]. The virtual simulation platform based on CDIO concept starts from the introduction of engineering cases from professional introduction[2], gradually decomposes the cases to the electrical machinery and other related courses, and constructs the virtual simulation system from the point to the surface to the body to the independent design, completes the innovation practice and gives the experimental platform data acquisition, and then designs the corresponding simulation model to complete the conception requirements for the engineering system. To debug, the corresponding subsystem can normally work under the GUI interface, and complete the platform display. The block diagram of virtual simulation 4D experimental platform design is shown in Fig.1.
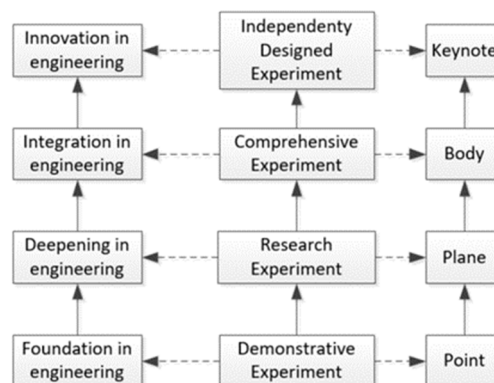

Figure 1. The block diagram of the virtual simulation 4D experimental platform design

2.2. Composition of simulation teaching platform

Traditional motor driving experiments have problems such as single teaching form and limited use time, and it is challenging to purchase high-voltage experimental equipment in large quantities for the existing funds of local colleges and universities so as to cultivate comprehensively applied talents under the background of new engineering [3].

The experimental platform utilizes virtual simulation technology to maximize the use of soft and hard resources in teaching, which is immersive, interactive and realistic. By combining the motor driving experiment with virtual reality technology, 3D reconstruction of the physical experimental equipment was carried out by using model construction, audio and video conversion, sensor, network technology, etc... Then the virtual simulation experiment platform was constructed to achieve 3D reproduction of the real experimental scene. Taking the constructed three-dimensional experimental equipment as the object, interactive technology is used to conduct experiments in virtual locations[4]. At the same time, the "experimental platform mode" of a single course is extended to run through the whole simulation platform with engineering cases as the starting point, from point to line, from line to surface, and gradually from DC motor to transformer to AC motor and then to innovative design, so as to stimulate students' interest in the professional course of electric machine and drive.
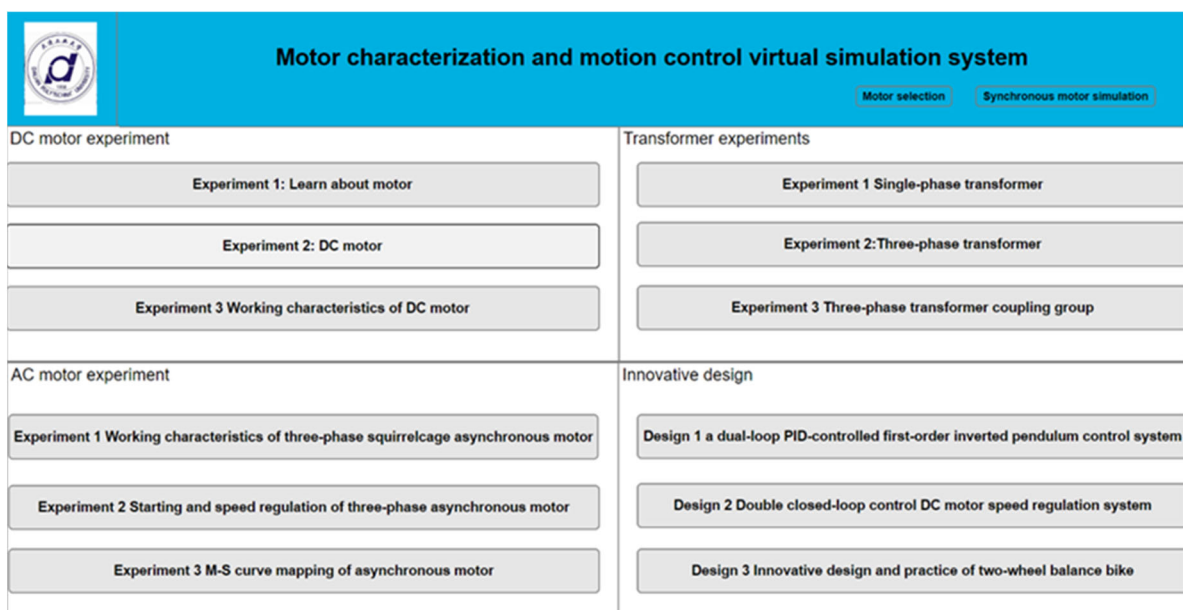

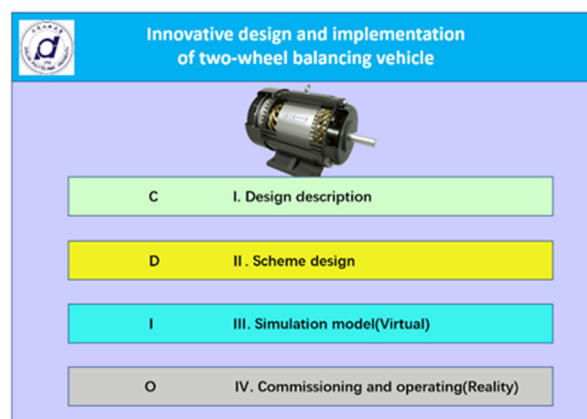**Figure 2.** Composition interface of virtual simulation platform

Figure 3. Implementation Scheme of CDIO Application Innovation Design

3. Integration of Theoretical Courses and Simulation Teaching

3.1. Experimental design of DC motor

Take the experiment of DC motor as an example, give our part of the design. Through our virtual simulation platform, students can intuitively feel the internal structure of the DC motor and

recall the theoretical knowledge points in class, such as the operation principle of DC motor and its relationship with the generator. At the same time, the relevant nameplate of DC motor is taken as the parameter, and the relevant experiment is selected.
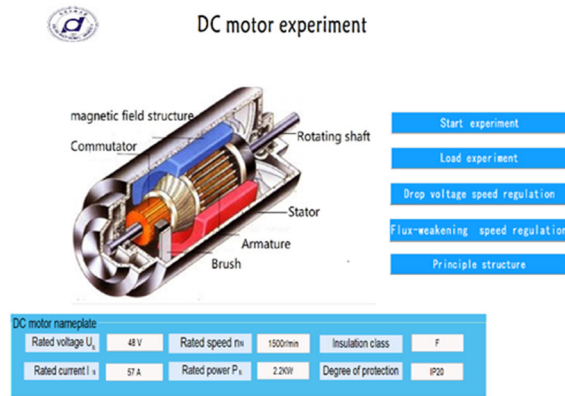

Figure 4. DC motor experiment

3.2.   DC motor starting experiment simulation model construction and simulation

After completing the 3D interactive demonstration model of the DC motor and having an image understanding of the basic principle and structure, to make students understand the difference brought by series resistance starting more clearly, we used Matlab/ Simulink module to conduct simulation design and construction of the motor running circuit, and realize data interconnection with the corresponding experimental interface [5].

In the component library of the Simulink tool, modules such as DC machine, Ideal Switch, Constant, Stair Generator and Oscilloscope are found respectively. Then build a Simulink simulation model for a DC motor start-up [6].

The starting simulation model of the DC motor is built, as shown in Figure 5. In the simulation model, each module is taken from the Simulink dynamic simulation module library. Then by setting reasonable simulation parameters and algorithm, the correct simulation results can be obtained by running. The result is shown in Figure 6. The starting of the motor refers to the process of the rotor accelerating from the initial static state to the stable running state after the motor is powered on. In the starting process of the motor, armature current I_a, electromagnetic torque T_{em}, and speed nwill change with time, which is a transition process.
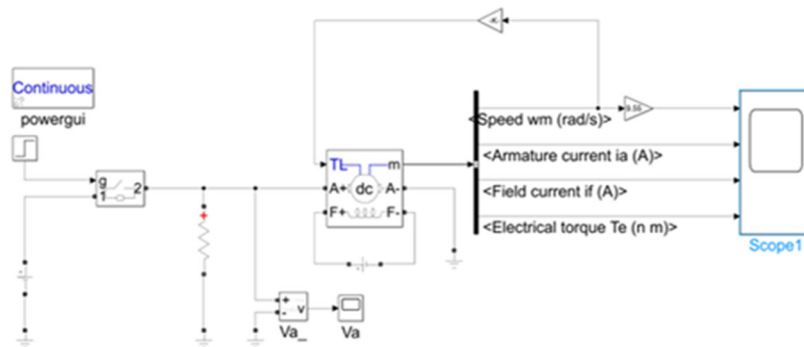

Figure 5. Simulation model of direct starting of separately excited DC motor

The direct starting current is $I_{st} = 300A$ in Fig.6,and the multiple of starting current is λ_st=300/57≃5.26. In Fig.8, the starting current after the series resistance starts is $I_{st} = 110A$, and the multiplier of starting current drops to λ_st=110/57≃1.93. After starting, the series resistor is removed, and the motor returns to running condition. With visual graphics, students can easily understand theoretically obscure knowledge.
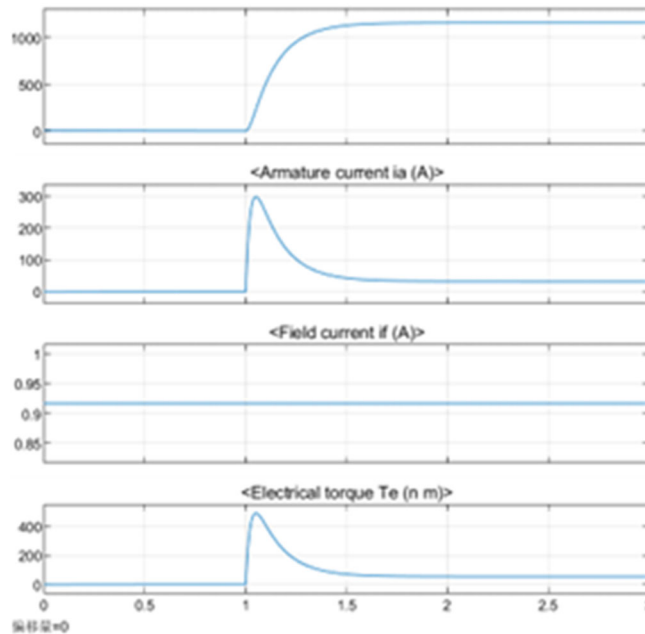

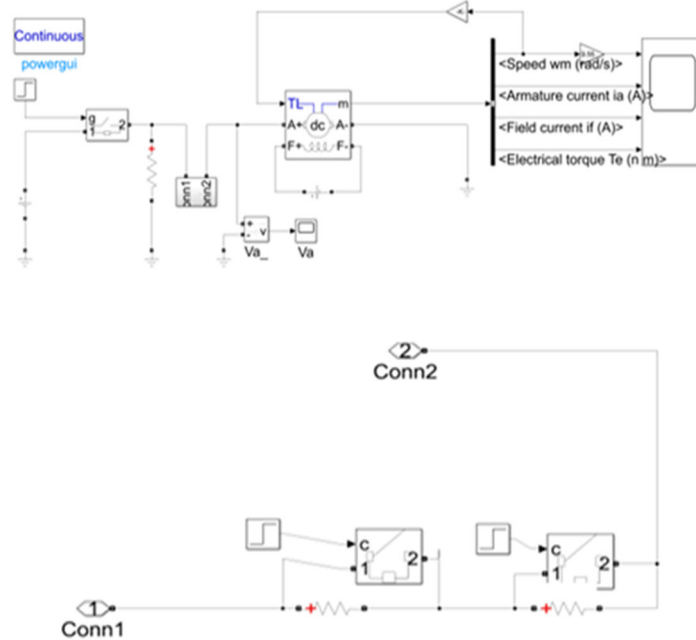**Figure 6.** Simulation waveform of Direct start of separately excited DC motor

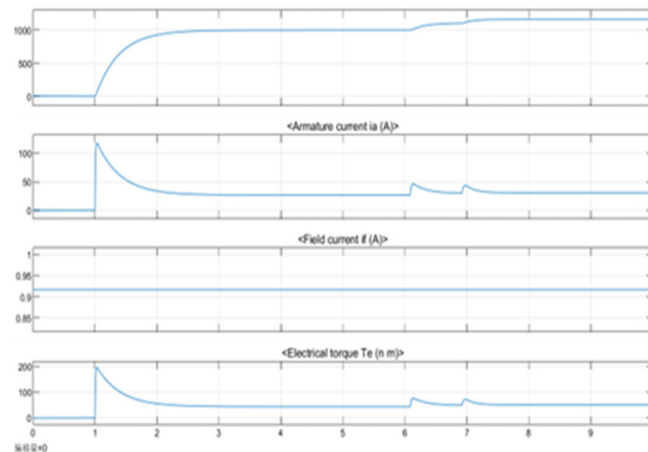**Figure 7.** Simulation model of series resistance starting of separately excited DC motor

Figure 8. Simulation model of series resistance starting of separately excited DC motor

4. Conclusion

Under the background of new engineering, the virtual simulation experiment platform of motor driving is built in line with the principle of "virtual-real coordination and virtual-real demonstration," which provides a new idea for training applied professionals. The development of virtual experiments is of vital help to improve students' hands-on and innovative abilities, and can effectively stimulate students' interest in learning. However, it is worth noting that a virtual simulation is only a new form of experiment and cannot replace traditional experiment. We can only get twice the result with half the effort by organically combining the two and learning from each other. It lays a solid foundation for cultivating high-quality applied talents.

The extensibility and portability of the platform are good, which can be extended to other courses. The subsequent development of multi-disciplinary virtual teaching platform can be carried out. The combination of virtual and practical can not only solve the problems of lack of experimental resources and experimental funds in the field of education, but also provide more students with the opportunity of exploratory experiments, and improve learners' ability of independent innovation and problem finding and solving, which is of great significance for innovative applied talents.

Acknowledgments

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