Application Study on the Virtual Reality Teaching Method of Electrical and Electronic Courses

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Abstract. In view of the application-oriented talents cultivation target and the problems existing in the teaching process of electrical and electronic courses, we designed and applied the virtual reality teaching method to help students improve their understanding degree of the abstract knowledge, analysis ability, learning interest and participation. We used the MULTISIM software tool to simulate the actual problem in classroom teaching practice. Through the detailed analysis of the virtual simulation experiment results, and combined with the theory of knowledge points, students would quickly master the knowledge and leave a deep impression in their minds. The application practice results shows that the method would make the teaching process more vivid and intuitive, and improve the teaching effectively. This method has important practical significance for the cultivation of application-oriented talents.

Introduction

With the entire demand for application-oriented talents in modern society, college education in practice-oriented courses teaching has been paid more and more attention, and the traditional teaching methods cannot meet the requirements of modern practice education and the cultivation of application-oriented talents. In general, the graduate education should play a more important role in the cultivation of application-oriented talents. However, if students can master a number of virtual reality simulation technology at the undergraduate level, then the follow-up study will be more effective. Therefore, we carried out the virtual reality teaching method in the undergraduate curriculum, along with the development of the work, we believed that it will achieve very good results.

Electrical and electronic courses is a kind of compulsory course for non-electric engineering specialty in colleges and universities [1]. It focuses on the cultivation of students' practical ability and the ability to solve practical problems, which is mainly used in the cultivation of application-oriented talents. These courses has the characteristics of strong comprehensive, short class time, variety and abstract content, difficulty understanding, and variety not-easy-to-remember theoretical method [2-4]. Therefore, students generally find it difficult to learn and understand, lack of learning interest and enthusiasm, lack of independent thinking and explore ability [5]. They accustomed to passive acceptance, and accustomed to the conclusion of the knowledge by ignore the concrete process of the results. It leads to the bad situation of not clear understanding of the content, and not effective teaching effect.

MULTISIM is an electronic circuit simulation software tool developed by National Instrument Co Ltd., which has more than 26000 virtual components in the library, and the parameters can be adjusted arbitrarily. It has many virtual testing instruments, such as oscilloscope, signal generator, potter chart, spectrum analyzer and others, for data and waveform display and storage. It also provides a number of circuit analysis methods of static analysis, transient analysis, AC analysis, distortion analysis, time domain analysis, etc., for the function of fault detection, working state observation, efficiency analysis, and so on. MULTISIM software can be fast, simple and effective to achieve the design and simulation of various circuits. It is an important means to cultivate application-oriented talents [6].
We used MULTISIM to achieve a large number of virtual reality circuit and applied them in the teaching of electrical and electronic courses. It makes the relevant concepts and theorems of the course easier to understand and master. Through the design and implementation of simulation experiments and analysis of the experimental results, we greatly improved the students' participation and learning confidence, but also the teaching effect has been greatly improved.

**Teaching Examples**

*Kirchhoff's Current Law.* In the past, teaching of this part of the content is usually made by the static circuit diagram, with the help of the current flow symbols and mathematical formula directly to the conclusion. It would be very boring of the teaching process, and students do not have any intuitive understanding, they will be very difficult to understand this kind of theorem.

Now, we used of MULTISIM software in the classroom to achieve real-time circuit simulation, guided students to complete the derivation of the theorem themselves. Through this, the theorem teaching process is more vivid, and students will have more deep understanding of the content.

![Figure 1. Simulation circuit of the KCL.](image)

Using MULTISIM software, create the simulation circuit of the KCL shown in Fig.1. R1 is an adjustable resistor of 10ohm; A1~A3 are ammeters. Here, we use A1~A3 to represent the current of the three branches.

<table>
<thead>
<tr>
<th>R1 (Ω)</th>
<th>A1 (A)</th>
<th>A2 (A)</th>
<th>A3 (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>0.586A</td>
<td>2.345A</td>
<td>2.931A</td>
</tr>
<tr>
<td>6</td>
<td>0.415A</td>
<td>2.448A</td>
<td>2.902A</td>
</tr>
<tr>
<td>8</td>
<td>0.321A</td>
<td>2.566A</td>
<td>2.887A</td>
</tr>
<tr>
<td>10</td>
<td>0.262A</td>
<td>2.615A</td>
<td>2.877A</td>
</tr>
</tbody>
</table>

Running the simulation, we can get the results under different R1 value with 2ohm, 4ohm, 6ohm, 8ohm and 10ohm shown in Fig.2. Students can get the results (Table 1) by observing and analyzing the experimental results themselves., continue to analyze the current values, they will find that \( A_1 + A_2 = A_3 \), because \( A_1 \) and \( A_2 \) are the flow of the current in, \( A_3 \) is the flow of the current out, which is: at any moment, all current in equal to all current out of the node in the circuit.

BUT, why there is a little error when \( R_1 = 6Ω \)? RIGHT, because it is virtual reality, so it must be considered that the impact of the instruments’ resistance and the other actual impacts to the experimental data.
**Figure 2. Simulation results.**
(a) R1=2Ω; (b) R1=4Ω; (c) R1=6Ω; (d) R1=8Ω; (e) R1=10Ω

Transmit process of one order linear electric circuits. The transient process of the one order linear electric circuit is transition process of the current state to a new steady state of the circuit, it is a circuit phenomenon which fundamentally due to the energy conversion of the reservoir elements cannot be instantaneously. It can be divided into three types of zero-input response, zero-state response and a full response. Since it is an abstract process, it is difficult for students to well understand this knowledge through theoretical analysis.

We use MULTISIM simulation software to create a RC simulation circuit shown in Fig.3, where, XSC1 is a virtual oscilloscope.

When the switch J2 is at position 1, running simulation, we will find that there is no energy storage to the capacitor C1 shown in Fig.3. It can be considered as the stable state (or current state) of the circuit at this time.

**Figure 3. RC circuit for transient process simulation.**

Now, we push the switch J2 to position 2 and run the simulation. Fig.4 shows the state changes of the circuit.
We can guide students to observe two questions: one is the energy of the capacitor element is increased or reduced; the other is if the energy increase is instantaneous? Obviously, the capacitor voltage is a gradual process, and this process is the transient process mentioned before. Through the simulation analysis, students can observe the phenomenon of the circuit intuitive. Then combined with the theoretical analysis, students can quickly grasp the knowledge.

If the switch is pulled back to the position 1, what will happened to the circuit state? The simulation results is shown in Fig.5.

From Fig.5, we can find that the capacitor will be discharged through resistance until the voltage is equal to 0. Through such an intuitive and vivid display, students will have a thorough understanding of the charging and discharging process and the existence of transient state.

Teaching Effect Comparison

Virtual reality teaching method has been successfully implemented in Lanzhou University of Technology for three semesters from spring of 2014. After the first semester for running in, the teaching effect of the electrical and electronic courses of the two followed semesters is getting better and better. Compared to the traditional teaching methods, students’ learning degree has been significantly improved.

<table>
<thead>
<tr>
<th>Courses</th>
<th>Average of the semester final exam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical</td>
<td>67.66</td>
</tr>
<tr>
<td>Electronic</td>
<td>69.31</td>
</tr>
<tr>
<td>Practical course</td>
<td>78.33</td>
</tr>
<tr>
<td>Laboratory session</td>
<td>88.56</td>
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</table>

In the autumn of 2015, we did a survey of satisfaction and support rate of the teaching method reform among students and teachers. Nearly 98% of the 900 participants are satisfied with the implementation of the virtual reality teaching method. The results of the investigation are shown in Fig.6. Thus, the implementation of such a teaching method is that everyone wants to see. At the same time, through the efforts of everyone, the students can grasp the abstract knowledge more easily in the
theory learning, but also reflect a better ability to analysis and design the circuits in the practice curriculum. It provides a learning foundation for the application-oriented talents cultivation.

**Figure 6. Investigation results for the implementation of the virtual reality teaching method.**

**Conclusions**

In this paper, we took some examples to explain how the MULTISIM simulation software based virtual reality teaching method applied in electrical and electronic courses. We introduced the method into the classroom teaching last year and analyzed the practiced results. Application results show that the method can visualize the abstract concepts and principles in electrical and electronic courses effectively. It help students to break through difficulties conductively, improve the students’ classroom participation degree, self-confidence, manipulative ability, learning enthusiasm and interest through deepen understanding. It also can effectively improve the teaching effect. Therefore, MULTISIM based virtual reality teaching method has a great significance to deepen the teaching reform in the teaching of electric and electronic courses. It has important practical significance to the cultivation of application-oriented talents in university.

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**References**


