An Educational Java Applet for Understanding Principles of Synchronous BCD Counters

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Abstract – This paper presents web-based Java applet for understanding the concepts and principles of synchronous BCD counter. Through our educational Java applet, the learners will be capable of learning the concepts and theories related to digital experiments and how to operate the virtual experimental equipments.

The proposed educational Java applet is composed of three important components: Principle Classroom to explain the concepts and theories of synchronous BCD counters operations, Virtual Experiment Classroom to provide interactive Java applets about the syllabus of off-line laboratory class, Assessment Classroom and Management System. With the aid of the Management System every classroom is organically tied together collaborating to achieve maximum learning efficiency. We have obtained several affirmative effects such as high learning standard, reducing the total experimental hours and the damage rate for experimental equipments.

Keywords : Educational Java Applet, Synchronous BCD Counters, Web-based Virtual Experiments

1. INTRODUCTION

Recently, much interest has been drawn on the web-based solution for the experiments at universities with large number of students due to low cost. Teaching is no longer confined to a time and a place. The time and physical boundaries of the traditional classroom are stretched to a learning space. A growing number of universities worldwide are now offering virtual education problems. A simple search on the World Wide Web will result in hundreds of sites offering virtual courses or resources for developing and delivering such courses. Electrical and electronic experimental study is a very important component in engineering education. It not only acts as a bridge between theory and practice, but also solidifies the theoretical concepts presented in the classroom.[1]-[3]

Before the laboratory session, the learners should reinforce basic concepts, prepare some design and simulation steps, and acquire a clear idea on what they should expect from the experimental work they will be carrying out in the laboratory. At the laboratory session, the learners are required to assemble the circuits, connect the equipment, make the measurements, compare the data to the expected behavior, and deliver a partial or complete report to the professor at the end of the session. This classical way of experimenting clearly has the following shortcomings.[4]-[6]

• The classroom lectures or the handouts are generally not sufficient for the learners to be fully prepared for a hands-on experiment or to appreciate the significance of the previously explained theory in the experiment to be performed.
• When the learners are passive observers or a semi-active part of an experiment, they will understand neither the correspondence nor the difference between theory and practice.

To cope with these difficulties, this paper presents methodology which can easily be used on the web by simple mouse manipulations. The methodology is to provide the learners with an educational Java applet which can enhance the multimedia capabilities of world-wide web. If the learners have access to the proposed Java applet through a typical web browser, they can make experiment on basic digital logic circuits through simple mouse clicks. Since this interactive educational Java applet is implemented to describe the actual on-campus laboratory, the learners can obtain similar experimental data through it.

In this paper, we implemented synchronous BCD counters by using Java applet as illustration. The implemented Java applet is composed of three important components: Principle Classroom, Virtual Experiment Classroom, Assessment Classroom and Management System. The proposed methodology can be used from elementary digital experiments to advanced electronic experiments included in the curriculum of the college of engineering. It has interactive multimedia contents to get the learners exact understanding of the concepts and theories of
digital circuit operations, and the learners can build their own circuits and measure all information about the status of the circuits on the virtual space by simple mouse manipulation. Every activity done in the educational Java applet is recorded on database and provided to the learners as a printout form including experimental information and results. The educators check the submitted printout form to estimate how well the learners understand the experimental contents.

The implemented Java applet can be used in stand-alone fashion, but using as assistants of the actual on-campus laboratory class shows more encouraging results.

2. STRUCTURE OF PROPOSED JAVA APPLET

In Fig. 1, the structure diagram of our educational Java applet is shown. All of this can be achieved by the aid of Management System. The database connectivity is made by Professional HTML Preprocessor and the virtual laboratory environment is set up slightly differently for each learner.[7][8]

2.1 Principle Classroom

*The Principal Classroom* is responsible for making the learners understand the concepts and theories of the circuit operations. Interactive Java applets with creative and intuitive ideas for each subject lead the learners to easily understand their operations.

Fig.2-Fig.3 show several important procedures from the educational Java applets for explaining the concepts of synchronous BCD counter. Using this Java applet, the learners can understand the wholes procedure that shows how the synchronous BCD counter will be designed. In addition, Fig. 2(a) shows the generation of initial and final state diagram for asynchronous BCD counter. When the learners click the decimal buttons, the corresponding binary codes will be displayed as shown in Fig. 2(b).

**Fig. 1 Structure of our Educational Java Applet**

**Fig. 2(a) The generation of initial state diagram**

**Fig. 2(b) The generation of final state diagram**

**Fig. 3(a) Blank text fields for the inputs of JK flip-flops**
Fig. 3 (b) Pop-up message in case of occurring mistakes

Fig. 3 (c) Complete text fields for JK flip-flops

Fig. 4 (a) Corresponding Karnaugh map for J

Fig. 4 (b) Simplification process by using Karnaugh map

Fig. 4 (c) Simplification process by using Karnaugh map

Fig. 5(a) Connection procedure for each JK flip-flops

Fig. 3(a) shows the process that fills out the given text fields according to the excitation table of JK flip-flop. If the learners make mistakes when filling out text fields, the pop up message will be displayed promptly as shown in Fig. 3(b). Fig. 3(c) shows complete text fields for each input of JK Flip-Flops.

Fig. 4(a) shows the Karnaugh map that simplifies the Boolean algebra for each JK flip-flop. For example, if the third input of JK flip-flop is selected, corresponding Karnaugh map will be displayed in the right-hand side. The Karnaugh map simplifies the Boolean algebra when the learners clicks the button labeled 'next' as shown in Fig. 4(b). Therefore, they can easily understand the simplification process of Boolean algebra. Note that the learners are able to understand not the simple results but the overall procedure for simplification of Boolean algebra. Therefore, the higher learning efficiency can be improved than that of conventional approach for web-based education.
Fig. 5 shows the overall connection procedure after simplification by Karnaugh map. For example, if the learners clicks each input button of JK flip-flops, corresponding digital logic circuit will be displayed in the left-hand side. When they clicks all of the buttons, overall digital circuit for synchronous BCD counter will be displayed as shown in Fig. 5(a)-(d), respectively. This is a semi-final stage of virtual experiments for an synchronous BCD counter.

2.2 Virtual Experiment Classroom

The Virtual Experiment Classroom provides virtual experimental environment to the learners. In this classroom, the learners can build circuits for each subject, set the values for each circuit element, and measure several digital outputs using the experimental equipments. When finishing the virtual experiment on the web, the learners can print out all information related to the experiment which can be used as preliminary report for on-campus laboratory class.

For example, Fig. 6 shows virtual experiment process for the completed synchronous BCD counter. To make virtual experiments for the completed synchronous BCD counter, the learners can observe the virtual experimental results when clicking the button labeled 'start'. In addition, they can make a variety of virtual experiments by changing initial states of each JK flip-flop. Therefore, the proposed educational Java applet is composed of five important steps to explain the concepts and design procedures of synchronous BCD counter. The 1st step provides the learner with state diagram and the 2nd step provides them with excitation table of JK flip-flop. The 3rd step provides them with Karnaugh map which corresponds to the excitation table and the 4th step provides them with the related circuit composition. Finally, they can observe the output waveforms of synchronous BCD counter for a variety of input conditions.
In the virtual experiment classroom, every activity done there will be recorded on database and printed out as a preliminary report form. Once students fill in the text fields with the virtual experimental data and click the button ‘SEND’, the data will be transmitted and recorded on the database. The virtual experimental data recorded on the database can be retrieved to generate a preliminary report form by the Professional HTML Preprocessor (PHP) module program. Since the virtual experiment classroom is designed to provide students with slightly different environments, their preliminary reports will not be shared each other. If a student performs the same virtual experiments twice at different time, two experimental results might be different each other. Note that these situations in the virtual experiment classroom are similar to those in the on-campus laboratory. During the virtual experiment session, students obtain several virtual experimental data from their own circuits. They are required to fill in the truth tables with their own data they got from the virtual laboratory. Also, they press the button ‘RESET’ and restart if there are some mistakes with filling out the truth tables.

Since the Virtual Experiment Classroom has an efficient virtual experiment applet with interactive multimedia contents, the quality of education and the learning efficiency can be improved.

2.3 Management System

Good instructional development is an iterative process by which the educators and learners perform formative assessments and summative evaluations to continually improve a course. Effective instructors use a variety of means, some formal and others informal, to determine how much and how well their students are learning.[9] Every activity occurred in the proposed Java applet will be recorded on database and printed out the preliminary report form. All of this can be achieved by the aid of Management System. The database connectivity is made by Professional HTML Preprocessor and the virtual laboratory environment is set up slightly differently for each learner. Fig. 7 shows database connectivity of the Management System using PHP.

3. CONCLUSIONS

We implement an efficient educational Java applet with interactive multimedia contents, which can be used to enhance the quality of education in the area of digital circuit experiments.

Our educational Java applet shows that the difficult concepts, principles and theories related to the digital experiments can be conveyed to the learners effectively by interactive multimedia contents.

The proposed virtual experiment applet has brought several affirmative effects such as reducing the waste time and labor of both the educators and the learners, and the damage rate of real equipments, and increasing learning efficiency as well as faculty productivity.

Finally, our educational Java applet for digital circuits can be proved a viable, effective and cost-
effective aid to the educational activities both for classes and for continuous education. We will challenge the advanced researches on the digital logic circuits in the near future.

REFERENCES