Comparison and Discussion of the Functions of Logisim and Multisim

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Abstract. Nowadays, microelectronics and integrated circuit technology are developing rapidly, this situation can not be separated from the support of electronic circuit simulation software. Circuit simulation software is widely used in research and work, such as Matlab, which is widely used in digital signal processing, Proteus, which is used in making PCB board, and AltiumDesigner, which is related to CAD technology. This paper first introduces Logisim and Multisim simulation software for circuit related experiments, which are used to assist students in courses and experiments. Then, two experiments are designed to evaluate these two software and analyze their advantages in the process of using them. According to the process and results of the experiment, Logisim is suitable for college students who have just come into contact with professional knowledge to learn circuit and computer related theories, and complete most of the homework assigned by teachers; While Multisim is more suitable for students with a certain knowledge base to expand the understanding of theory and simplify the experimental process. Experienced students can also choose this software after participating in the competition to improve the efficiency and level of their entries.

1. Introduction
Experiment has always been an indispensable part in the courses of science and engineering majors. As the most direct way to transform theoretical knowledge from books into practical experience, doing experiments can greatly help students to acquire otherwise obscure theoretical knowledge. Circuit experiments are widely used in various science and engineering majors. Communication, electrical, computer, automation and many other majors are involved in circuit knowledge [1]. At present, there are some problems in the circuit design in general universities: long learning time, high learning cost, too much dependence on laboratory environment, etc [2]. Logisim and Multisim introduced by the author in this paper are specially used for circuit simulation software, these two software are easy to get started, the interface is simple and intuitive, circuit design and simulation are very efficient, which is good for students to start practical operation. In addition, software can be completely separated from the limitations of hardware equipment. Nowadays, some experimental equipment are damaged in many universities. These problems can be avoided by the software.

2. A basic introduction of two kinds of software

2.1. Basic introduction of Logisim
Logisim simulation software is a Java-based application that can support any Java environment platforms and can be run by downloading the most basic Java scripts from the Internet. Because
Logisim is a free and open source software, there is no commercial software license, no students fee, and no piracy problems. The software is easy to use and easy to learn, and the simulation results are intuitive and easy to understand. It is suitable for the design and simulation of digital logic circuit. In addition, Logisim allows users to further develop, which is beneficial for students to expand their own learning direction and content [3].

2.2. Basic introduction of Multisim
Multisim is a Windows-based simulation tool developed by National Instruments (NI) for the design of analog/digital circuit boards at the board level. It includes graphic input of circuit schematic diagram, input of circuit hardware description language. In addition, it has rich simulation and analysis capability. Now most universities are using Multisim 10 version, its characteristics are as follows: (1) Instruments can be created according to your own needs; (2) All the virtual signals can be output to the actual hardware circuit through the computer; (3) All the results of the hardware circuits can be fed back to the computer for processing and analysis. Multisim software can easily complete the design and simulation of a variety of analog and digital circuits. Students only need to master the use of the software, so that they can benefit from the subsequent courses continuously [4]. In this paper, an updated version of Multisim 11 is adopted.

3. Evaluation of key functions

3.1. Evaluation of Logisim key functions
Next, the main interface of each software will be introduced, starting with Logisim. It can be seen from the first part that the first three flags of the first line represent three working modes, namely editing circuit, selecting area and adding text; The last four marks represent the input/output and and/or/nand gates, which are the three most basic gates in digital circuits. In addition, the software provides several logic gate choices, students can use these relatively simple logic gate to build more complex logic circuit. Besides, it can help students write expressions in the output end to compare with the actual output.

In addition to subtraction, multiplication and division, Logisim contains an algorithm that can also calculate binary complement and complement. Computer-related functions such as comparators, shifters, finders and parity checkers can also be found in Logisim. The scope of memory in the circuit is generally more extensive, the three common triggers in the digital circuit: RS trigger, JK trigger, D trigger can be directly called in Logisim function, convenient for students to directly observe the working mode of the trigger. In addition, the MCU principle of the key knowledge - register, which can also be learnt in Logisim, such as ROM and RAM concepts and properties as well as the function of various flag registers.

3.2. Evaluation of primary function of Multisim
Multisim's interface is significantly more complex than Logisim's basic interface, and this paper will focus on its Place feature, as shown in figure 1. The bottom line shows the types of components that can be placed. General electronics, communication, computer are involved in the electronic components, including a variety of power supplies such as resistors, capacitors, inductors, transistors and audions. Values will be set independently. What is more, Multisim can call a variety of chips common in experiments, such as 74LS138 and 74153N. In complex circuit experiments, any defect of the instrument and the connection line will affect the correct result. With Multisim, the simulation can be synchronized with the experiment to ensure the smooth operation of the experiment. With Multisim, not only can the circuit be accurately analyzed, but also the principle of electronic circuit can be deeply understood. At the same time, the circuit can be boldly designed according to the designer's idea, without worrying about whether the experimental equipment is damaged or not [5].
Since the classification of components is quite detailed, users need to make use of the search function. They can often find the components they want quickly by searching by category and name.

3.3. Comparison of the advantages of the two kinds of software
Logisim is characterized by a simple and clear interface that facilitates detailed operations. Users can see all the attributes of a single component with the mouse. Furthermore, these attributes can be adjusted in the table on the left: They can meet the real-time needs without changing the large layout. Logisim's intuitive expression is very suitable for beginners and it can effectively help them lay the foundation of the circuit. Multisim, on the other hand, has a huge, detailed database and a variety of spin-offs. Whether completing homework or participating in competitions, students will encounter circuits and components that they do not understand. When the laboratory cannot be used, Multisim can easily and correctly compose circuits and complete simulation. In addition, students can change the properties of circuits based on similar chips and transistors, expanding their knowledge.

4. Counting device circuit design and imitation
In order to test the practical application of the two software, the author designs two counting circuits with Logisim and Multisim respectively. The followings are the experimental process and circuit functions.

4.1. Raise hand to vote and count” circuits
A show of hands counting circuit, as the name suggests, is a circuit that counts the votes according to the number of people who voted yes and no. The twelve inputs on the left side of the picture represent the twelve persons’ voting, with "1" for yes and "0" for no. The whole circuit is shown in figure 2. The upper part is responsible for counting the total number of affirmative votes, while the lower part is responsible for counting the total number of negative votes. The counting function of the circuit is realized by several adders, and finally a four-digit output will be obtained, the output represents the binary number form of votes of approval and votes of disapproval. The author chose to use seven digital tubes, because the total number of people is two decimal numbers, two digital tubes are needed to present the results. Finally, the digital tube display function is realized according to the input of four binary numbers to change the luminous situation of each digital tube. Because the circuit is too tedious, the author will implement this part through the subcircuit (4,5).
Next, the paper will supplement the main areas needed in the design process. It comes to adjust the adder data bit width, the system default bit width is 8, and the circuit input is a digit, so the first column adder bit width should be changed to 1; Similarly, the four adders in the first column provide four four-digit inputs. The whole row is a four-digit input, so change the column width to figure 3. Then there is the circuit editing of the subcircuit, which usually requires drawing the Knot diagram according to the truth table, analyzing the Knot diagram to obtain the expression, and then repeating the process one by one, the whole process is too cumbersome and error-prone. At this time, it is necessary to use Logisim's analysis circuit function. People can directly establish the circuit by filling in the truth table to obtain the expression of each section (for example, Output $= \neg A_2 \neg A_0 + \neg A_3 A_1 + A_2 A_0 + A_3 \neg A_1$), which is very convenient.

4.2. *Arbitrary decimal system counting device circuit*

This circuit mainly uses 74LS160 chip to realize the counting function of any base, and Multisim provides many chip functions can be fully played. 74LS161 is a common four binary preset synchronous addition counter, the synchronous preset decimal counter by four D flip-flop and a few gate circuit, internal advanced position, with counting, set the number, prohibit, direct (asynchronous) clear zero and other functions. This paper will use simple function 74LS160 to explain. 74LS160 [1,2]
is an integrated synchronous decimal adding counter, which is designed with synchronous setting number control terminal, asynchronous setting zero control terminal, one clock pulse input terminal, two counting control terminal ENT and ENP, four parallel data input terminal A–D(D is the highest input bit, A is the lowest input bit, four output terminal QDQCQBQA(QD is the input. The highest bit, QA is the lowest bit and 1 carry output RCO. Using the synchronous number control terminal and the asynchronous zero control terminal, users can realize the addition counter in different bases [6]. QAQBQCQD The output value of the four output pins represents the number at a given moment (the logical expression on the carry output of 74LS160 is RCO=ENTꞏQD ꞏQA). An output value is connected to the LOAD pin of the chip to complete the cutoff recount. The output in figure 4 is Q3Q1, which represents 1010 and is the decimal system. By default, the system starts counting at 0 and stops at 9, it is a cycle. Since 10 is a two-digit number, this circuit has only one output, so it can not carry out more than 10 base, and has considerable limitations. When the technical capacity needs to be expanded, multiple 74LS160 or 74LS161 chips can be integrated with cascading counters [7].

Figure 4. Any base counter circuit

5. Conclusion
Logisim is suitable for beginners to understand the circuit knowledge. It can also cultivate their interest in learning. Thus, students on a certain basis can design their own circuit. In contrast, Multisim is more suitable for completing a specific circuit design requirements, and can efficiently solve the problems of difficult operation on hardware. By designing circuits on a software simulation platform, students can translate what they learned in class into practical applications, not just written assignments and exams. Nowadays, many mainstream courses in engineering are subject to course design, and the experimental situation determines the final grade. After learning how to use these software proficiently, students can significantly improve their experimental scores. However, it needs to be noted that students can not only use software, hardware system design and debugging ability can not be ignored either. Finally, it has to be illustrated clearly that although Logisim and Multisim can satisfy a majority of need in curriculum during undergraduate period, students are always required to pick up latest or specific software and technology in postgraduate period and after starting working. Students should learn more after they become proficient in these two softwares.

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