A Research of Web-Based Simulation Tools in Electrical Engineering

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INTRODUCTION

A Web-Based Circuit Simulation Tool is an online platform that enables users to create, evaluate, and test electrical and electronic circuits without the need for tangible parts. Users can construct circuits using drag-and-drop components in these virtual environments, test circuit behavior through simulations, and examine results using visual outputs like graphs and waveforms, offering a convenient and accessible platform for learning and experimentation. Key features of Web-Based Circuit Simulation tool are Component Libraries which prvoides a wide range of electronic components like resistors, capacitors, transistors, and microcontrollers, Simulation Modes that are DC analysis, AC analysis, transient analysis, and digital logic simulation. Interactive Visualization and Collaboration.

There are also tools that are useful for students, hobbyists, and engineers to test designs before physically assembling a circuit, saving time and reducing errors. These tools are Tinkercad Circuits, EasyEDA, Falstad Circuit Simulator and CircuitLab. A Web-Based Circuit Simulation Tool offers many things such as eliminating the need to purchase expensive components, test equipment, and breadboards, enables learning and designing circuits anywhere, anytime, real-time simulation allows users to see how circuits behave instantly, Helps students and beginners understand circuit concepts through visual representation, and allows users to experiment freely without damaging physical components.

DISCUSSION

1. What are web-based circuit simulation tools (e.g., Tinkercad, Multisim Live, LTspice Web)?

2. How do cloud-based CAD tools assist in designing electrical systems?

3. What are the advantages and limitations of using online simulation tools instead of traditional lab equipment?

ANSWERS

In this section, we will be answering the following questions stated on the Discussion part.

1. Web-based circuit simulation tools are online platforms that allow users to design, analyze, and test electrical and electronic circuits without the need for physical components. An example that we will use is Tinkercad. Tinkercad is a computer-aided design (CAD) software program that assists individuals and organisations in the manufacturing and promotion industry. It also caters to the healthcare and architecture sectors. Freeware makes editing files easy, allowing you to recreate existing designs. Designers can add and modify old 2D and 3D plans, too. Tinkercad is a simple 3D design and modelling software for anyone based on a browser, suitable for students of all ages and abilities. It is a website that helps you, along with your own fingertips, to create problems at a convenient time. It is free and runs with an internet connection on each device. Tinkercad is also a web-based software application that allows teachers to create an account and to use a code to invite college students to join (Abburi et al., 2021).

2. Cloud-based **Computer-Aided Design (CAD) tools** streamline the process of designing electrical systems by offering powerful features for schematic design, circuit simulation, and PCB layout, all accessible online. A study conducted by Chun-Chih Kuo & Chia-Hung Chang (2022) titled "Cloud-based design system for customized electrical enclosures" represented a solution to their problem which is proposing a cloud-based design system (CBDS) integrating a cloud-based design service platform (CDSP) and a CAD-based automated design system (CADS). The researchers also present a means of integrating the two so that when users submit their product specification requests on the CDSP, the CADS completes the design immediately, and the results are sent back to the clients to view on the CDSP. The proposed CBDS tries to solve the time-consuming, possible human error design process between customer and designer and decrease the total design time from request to actual design (Chun-Chih Kuo & Chia-Hung Chang, 2022).

3. First we will talk about the advantages of online simulation tools compared to traditional lab equipment. The advantages of Online Simulation Tools are Cost-Effective, Fast & Risk-Free Prototyping, Real-Time Simulation & Visualization, and Collaboration & Cloud Storage. Now the limitations of Online Simulation Tools are Dependence on Internet & System Performance, Less Hands-On Experience, and Licensing & Feature Restrictions which may require subscriptions. There was a study conducted by Finkelstein et al., (2005) that had two groups of students, those who used real equipment and those who used a computer simulation that explicitly modeled

electron flow, were compared in terms of their mastery of physics concepts and skills with real equipment. The result showed that students who used the simulated equipment outperformed their counterparts both on a conceptual survey of the domain and in the coordinated tasks of assembling a real circuit and describing how it worked (Finkelstein et al., 2005).

CONCLUSION

Electrical circuits can be designed, tested, and analyzed using web-based circuit simulation tools, which offer a strong and user-friendly platform without requiring actual components. Because they provide real-time simulation, affordable prototyping, and cloud-based collaboration, these tools—like Tinkercad, EasyEDA, and CircuitLab—improve learning and collaboration.

By combining PCB layout, circuit simulation, and schematic development, cloud-based CAD solutions further simplify electrical system design while increasing productivity and lowering human error. Online simulation programs do, however, have drawbacks, such as a lack of practical experience and a reliance on internet connectivity, despite their benefits, which include price and simplicity.

All things considered, studies indicate that students who use simulation tools rather than only conventional lab equipment can grasp circuit concepts more deeply. Simulations are a useful addition to traditional learning and professional design workflows, even though they cannot completely replace actual experimentation.