Development of simulation algorithm for online electrical measurements Lab

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***Abstract*— The purpose of the project is to develop a simulation algorithm that has the potential to enhance the learning experience of students by providing a virtual environment of the electrical measurement lab. The methods used here are jsPlumb toolkit, integration of HTML, CSS, and JavaScript, logic to generate ids of circuit elements and identify them, and a verifying algorithm that ensures the user gets the feel of making circuit connections in real-time, checking connections, validating the user input and showing the final results in the observation table. The unique thing in our project is that we can dynamically simulate the circuits. This application can be used for practical components in the case of online and distance learning courses and also if there is resource constraint.**

Index terms: *jsPlumb, HTML, CSS, javascript, and vlab.*

I. INTRODUCTIÓN

THe COVID-19 pandemic has caused significant transformations across multiple sectors, including the economy, production, manufacturing, healthcare, and education. Also to cope with the high cost of electrical equipment and technology, educational institutions have shifted towards online and remote learning methods. In response to this challenge, the Indian Government's Ministry of Human Resource Development (MHRD) initiated the National Mission on Education through Information and Communication Technologies (NME-ICT) program, which provides virtual labs to enable online practicals. With this motivation, we have developed a web-based platform to perform electrical engineering experiments, So that teaching and learning activities can be maximised both formally and informally to obtain effective and quality learning outcomes. Then students will be able to actively think like offline learning in the laboratory. They can also perform experiments repeatedly to understand the process better, and result. This also solves the problem of the number of students per practical as here students will have individual setups for each experiment.

II. METHODOLOGY AND TECHNICAL CONTRIBUTION

In this project, we have used jsPlumb to make it possible to drag and drop circuit elements from the toolbox to the working area. jsPlumb is an open-source project written in Typescript that gives tools that visually connect DOM elements. Dragged elements have been provided with two terminals one working as a source and another as a target. A connection originates from the source terminal and ends at the target terminal. Elements and connections can be dragged anywhere in the workspace. After making all connections as per the given instructions, the circuit will be verified. From each connection, two element ids are obtained, among which the first one corresponds to the id of the source element while the other is the id of the target element. Once all the source and target element ids are known for each connection, a map is generated that consists of the element id and the other elements' id connected to it. Now we can check if an element is connected to the right element as per the correct circuit diagram or not. After making the right connections circuit will be frozen and the user is asked to give the inputs for the value of resistances and battery. Now the input is read, validated with practical values, and the necessary calculations are done. For example in the experiment of the Wheatstone bridge, the Balancing condition of the bridge is checked first :

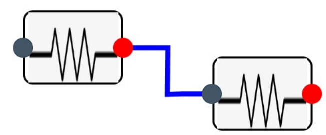

Figure 1. Circuit elements connection (Red dot- source, Black dot- target)

$$\frac{R_1}{R_3} = \frac{R_2}{R_4}$$

Now if the condition is satisfied then the current through the galvanometer will be zero, else:

Voltage difference between terminals of the galvanometer:

$$V_{Th} = \frac{V * r_3}{(r_1 + r_3)} - \frac{V * r_4}{(r_2 + r_4)}$$

Thevenin equivalent across galvanometer:

$$R_{Th} = \frac{r_1 * r_3}{(r_1 + r_3)} + \frac{r_2 * r_4}{(r_2 + r_4)}$$

Current through the galvanometer:

$$I_g = \frac{V_{Th}}{R_g + R_{Th}}$$

If Ig is positive then the direction of current is up to down through the galvanometer else it's the opposite.

Now, these values of resistors, voltage, and current are automatically entered into a dynamic observation table and the input field is cleared.

III. SIMULATION RESULTS

The Frontend part of the simulator consists of HTML, and CSS, and the backend consists of javascript codes along with jsPlumb code to make the circuit. The left part of the window consists of three buttons where instruction, the formula used, and the dynamic observation table can be seen. The circuit is made by dragging elements from the toolbox to the workspace and making connections. After completing the circuit, on clicking the "check circuit" button, an alert message is popped up that gives the verification status of the circuit. After reading and validating the user input calculations are performed and a new row of values is added to the observation table.

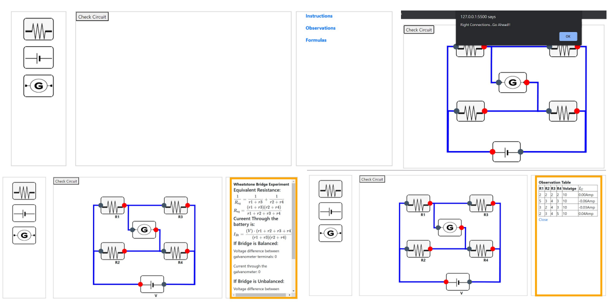

Figure 2. Simulation Results

IV. CONCLUSION

In recent times, numerous research studies have focused on the benefits and importance of virtual labs. To improve student motivation, alternative strategies are required to address the challenges associated with the conventional laboratory learning environment. In the context of electrical engineering, virtual labs can substantially enhance practical learning by providing a solution to overcome limitations related to outdated equipment and materials in educational institutions. They offer an excellent option for colleges and universities, particularly those with limited infrastructure and resources, to accommodate practical courses with all their constraints. Also, students are prone to electric shocks and sometimes they are not able to handle equipment properly in the laboratory which incurs losses. There are more bridge experiments like Carey foster, Maxwell, and Owen's Bridge which can be simulated in the same way. Also, improvement may involve displaying a moving needle in the galvanometer.

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