VR Lab for Enhanced Learning Testing & Analysis Report

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Activity Report

Abstract—Virtual Reality (VR) has emerged as a promising technology for enhancing educational experiences, offering immersive environments that facilitate active learning and engagement. In this paper, we present a VR learning experience designed specifically for electrical engineering education. Leveraging the capabilities of VR, our immersive learning environment provides students with interactive simulations and practical scenarios to deepen their understanding of fundamental electrical engineering concepts.

Index Terms—Virtual Reality, VR Learning, Electrical Engineering, Immersive Learning Environment, Interactive Simulations.

1 Verification Testing

In modern software development, ensuring the reliability and functionality of software systems is paramount. As software becomes increasingly complex and integrated into various aspects of daily life, the need for rigorous verification testing methodologies becomes ever more critical.

1.1 Repeatability

The project is capable of being reset and replayed consistently without bugs and issues.

1.2 Reproducibility

The project is currently pushed to GitHub, where others can pull or fetch the most up-to-date version.

1.3 Performance

With limited playtesting, we have found and reduced bugs and ensured gameplay flow. Currently, there are no known bugs.

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2 Validation Testing

Prototyping and debugging are critical in the early stages of validation testing. Quality assurance is ensured only when the needs and specified requirements of the intended users are met.

2.1 Remote Repository

Utilizing the free, open-source application, GitHub Desktop allows us to push our project to a remote repository on GitHub. This enables individual contribution outside of dedicated lab hours as remote access to the repository allows for more opportunities to develop inside the project environment.

2.2 Hardware Support

Previously, the VR environment was running through the Meta Quest App, which is intended for Meta Quest VR devices. By switching to the SteamVR API, we've expanded the compatibility to other VR hardware supported by SteamVR. This allows for playtesting and debugging outside of the Meta Quest devices we're currently using.

2.3 User Interface

The User Interface (UI) includes the customizable main menu, Figure 1, which allows the user to communicate their intentions with the environment. By interacting with the UI, they are able set component specifications and spawn in said actors. A sub-widget menu, Figure 2, shows a list of supported components.

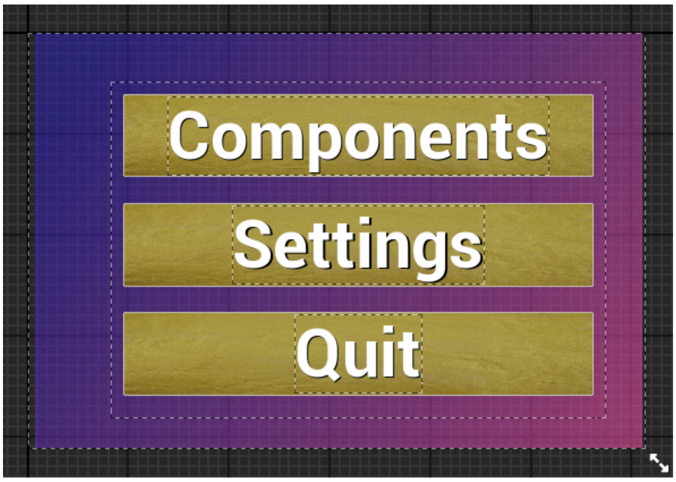

Figure 1. UI Main Menu version 1.0

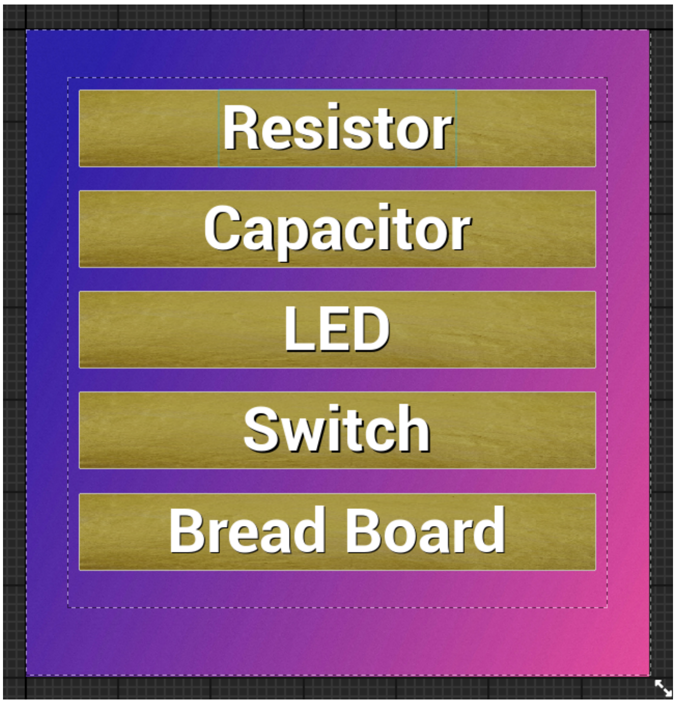

Figure 2. UI Component Sub-Widget version 1.0

2.4 Environment Setup

Some setup is required to properly utilize our software. Initially, there is a hardware requirement on behalf of the user, that being the VR headset and controller combination. In addition to this, a headset-linking application is required, such as Meta Quest or SteamVR. Once a proper connection has been created, app usage should function seamlessly.

2.5 Spice Simulation

Spice Simulation is currently at about 30% completion. The next step involves collecting data from the environment and generating a netlist based on this data to simulate on Ngspice. Following the simulation, the results will be imported back and ideally displayed in the user interface created within the environment. A concept, Figure 3, is shown to aid with visualization.

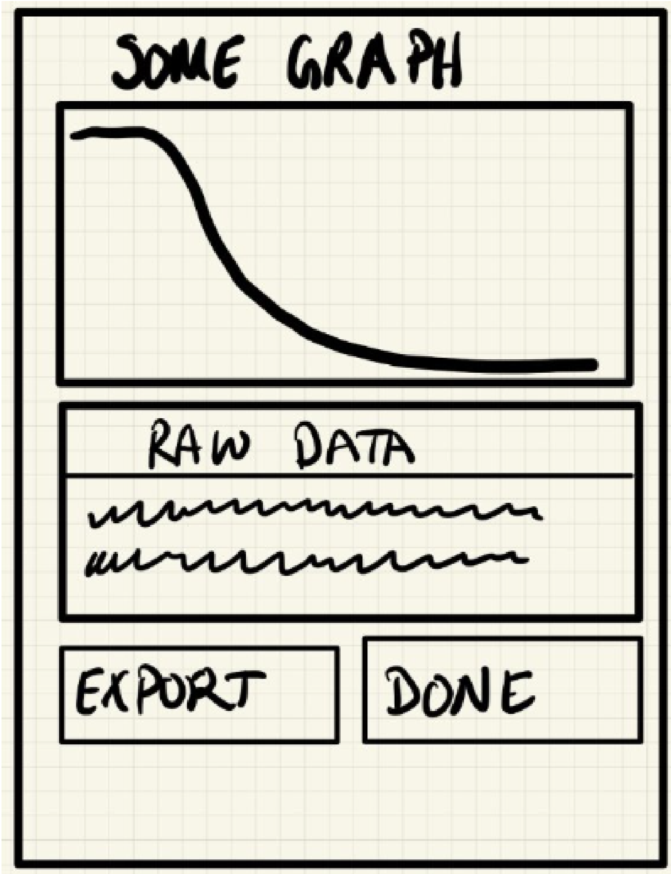

Figure 3. Conceptual simulation data imported into UE5

2.6 Component Design

Component design is approximately 80-100% done. The remaining tasks involve importing additional components into the environment from Fusion360 and assigning values to these components.

2.7 Lesson Plan

The lesson plan is about 30-50% complete as it lacks specific learning materials, detailed instructional activities, clear learning objectives, and alignment with educational standards. Below are the ideas we have brainstormed for our lesson plan:

- **Basic Circuit Building:** Introduce students to fundamental circuit components such as resistors, capacitors, and LEDs, guiding them through the process of constructing simple circuits in VR with virtual/3D components enabling them to experiment with various configurations to observe how changes impact circuit behavior.
- **Electronic Component Visualization:** Utilize VR to explore 3D models of electronic components to allow students to examine their physical structure and internal workings. It will also enhance their understanding of component properties, such as resistor color codes and capacitor markings.
- **Circuit Analysis:** Provide students with pre-built circuit design emphasizing the comprehension of parallel and series connections.
- **Electromagnetic Fields and Circuit Simulation:** Use simulations to visualize electromagnetic fields around conductors and components. Also, demonstrate the principles of inductance and capacitance through interactive simulations.

3 Data Analysis

*** NO DATA IS BEING COLLECTED. THEREFORE, WE ARE UNABLE TO PROVIDE AN ANALYSIS *****

4 Results & Discussion

*** NO DATA IS BEING COLLECTED. THEREFORE, WE ARE UNABLE TO PROVIDE DISCUSSION ON RESULTS *****

5 Future Work

Listed below are a select few items we would like to see implemented, given the project were to continue into another build:

- **Realistic Environment:** Source detailed 3D models and textures for realism and incorporate spatial audio for enhanced immersion
- **FETs and BJTs:** Integrating Field-Effect Transistors (FETs) and Bipolar Junction Transistors (BJTs) into the environment can offer hands-on learning and introduce students to the fundamentals of transistors and semiconductor devices.
- **Gates and Switches:** Integrate 3D models of gates and switches and their functionality.
- **Bode Plots:** Integrating Bode plots into a UI within a game environment to introduce students to frequency response analysis and signal processing concepts.
- **Advanced Topics Exploration:** This will introduce advanced electrical engineering concepts such as digital logic circuits, operational amplifiers, and microcontrollers.

6 Conclusions

Our VR learning experience represents a significant advancement in educational technology, providing students with a dynamic and immersive platform for mastering electrical engineering principles. As VR technology continues to evolve, we anticipate further enhancements and refinements that will further enrich the learning experiences of future generations of electrical engineers.