

Virtual Reality Lab using Unity3D for Educational Applications using ESP8266 for Digital Electronics

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Abstract—The use of VR in technical education has several advantages. In a wide domain of digital electronics, the study outlines efforts done to use VR to engineering education. To conduct experiments in a digital lab, the section offers guided domain exploration. A.pk files are used to store the created virtual laboratory. E-Labs' project: Virtual reality (VR) technology is used to create the remote laboratory known as digital electronics. The E-labs are primarily designed for fundamental and general gates experiments in digital electronics. This E-labs has the extra benefit of having both hardware and software (Blended mode). The software component is carried out with the aid of the programme unity, which is typically used to create simulations and video games for computers, consoles, and mobile devices. A virtual 3D environment was created for this project using Unity. Additionally, Blender software and Tinkercad from Autodesk are used to create the models needed to construct a virtual 3D world. The hardware portion includes a number of parts, including an Arduino Uno, a Wi-Fi module (NodeMCU ESP8266), an LCD, ICs, LEDs, and a breadboard. The Wi-Fi module and LCD are both linked to the Arduino. To show the results of the research, we utilise LEDs. A Wi-Fi module is attached to the experiment section, which also contains ICs and LEDs. To see the virtual world, the user needs put on a VR headset. They may choose the needed experiment that they would want to carry out, and any modifications made to the virtual environment will also be mirrored in the physical system. When there is a pandemic and students are unable to undertake physical experiments at their schools or institutions, the E-labs are quite helpful. Additionally, these E-Labs will pique students' interests and foster their desire to study new things while enabling them to comprehend subjects at their own speed.

Index Terms— Unity, Virtual Reality, ESP8266, microprocessor. Blender, Laboratory, Signal Processing, 3D, Open-SSL.

I. INTRODUCTION

In the teaching of science and engineering, laboratories are essential. The constructivist method of teaching emphasises student-centered learning, where students create their own knowledge via practical application and expanding on what they already know. This method is especially well suited for scientific education.

Technology has had a significant impact on both academic and industrial fields during the last several years. A study plan usually includes the application of new technologies to explore pedagogical difficulties. The thought that we would be able to continue to view ourselves as a civilisation If we adopted new technology to our

learning system. Teachers should use innovative strategies to enhance instruction for a number of compelling scientific and political reasons. It enables the development of online learning resources to prioritise its duties and enhance future online students' academic achievement. Additionally, educating students on new technology will enhance their work abilities, which is crucial for graduates of higher vocational colleges. In a virtual reality setting, the virtual world simulates the real one; in an augmented reality setting, the system superimposes virtual material and the actual setting to improve the real one.

Virtual Reality (VR), also known as immersion multimedia, replicates a virtual environment that resembles a physical presence in real-world or imagined environments, enabling the user to interact with that environment. Through engaging and memorable experiences, virtual reality may enhance learning. Virtual encounters have the capacity to engage and motivate pupils in a unique and potent manner. Instead of replacing conventional teaching techniques, virtual labs or remote labs should only be seen as an additional tool that may significantly increase students' comprehension and motivation. Basic digital lab experiments, such as NAND (IC 7400), NOR (IC 7402), OR (IC 7432), AND (IC 7408), and NOT gate (IC 7404), were applied in our research.

II. METHODOLOGY

System-based on actual equipment, remote experimental labs enable students to carry out practical work using a computer linked to the internet. Our project's primary goal is to construct the E-Labs and carry out the digital lab experiments described in the introduction, which aids students in bettering their comprehension and allowing them to comprehend in their own environment.

The additional benefit of a remote lab is that because the virtual lab will be linked to the hardware system, any modifications made there will also be reflected there. The hardware system is first created independently (without interaction with the Virtual Lab). Arduino UNO, ICs, ESP8366 (Nodemcu), and a relay make up the system. To confirm the operating conditions, a separate test is conducted on this system. The technology is further connected with the lab for virtual reality after testing. The Hardware component essentially enables the user to do physical experiments. Additionally, the Hardware section will reflect any modifications made to the software or virtual lab. IOT is utilised to complete the integration, and an arduino and wifi module are also employed so that any input from the user in the virtual lab will also be reflected in the hardware portion. The software component, which uses a programme called Unity3D to create it, is connected with the hardware system.

Unity3D is utilised to construct a 3D environment. The cross-platform game engine was created by Unity Technologies and is mostly used to create computer simulations and video games. Autodesk's Blender and Tinkercad software is used to create the three-dimensional models. It is a 3D computer graphics programme that is open-source, free, and used to create 3D printed models, motion graphics, interactive 3D apps, virtual reality, and visual effects. The virtual environment is represented in the Figure 1 below.

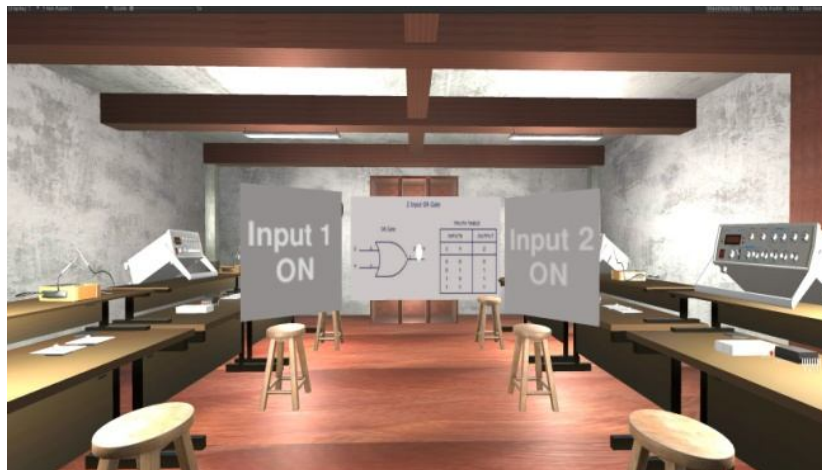


Figure 1. Front-view of the proposed system

A. Software

The new project must first be set up in Unity 3D after installation. Once this is finished, the models will be created in the blender and Tinkercad by Autodesk programmes, imported into the unity software, and then

placed inside the unity. An example of a trainer kit that is utilised in our VR lab may be seen in the picture below. The next phase is to build a 3D virtual lab environment with the aid of these models, after which the code for the models that has been implemented for testing. The last step is to conduct lab tests and evaluate the results. The software approach to the proposed system is depicted in Figure 2.

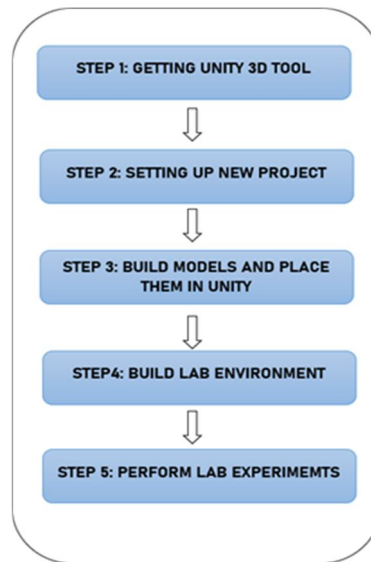


Figure 2. Flow diagram of the software setup

B. Hardware

An Arduino Uno is utilised to construct the hardware system, and a Wi-Fi module to link it to the IOT. The breadboard will then be linked to the Arduino, and ICs and LEDs will be attached to this. The experimental component of the hardware system is the ICs and LEDs. The output is shown on an LCD. A LED is used to show the output's status of the laboratory.

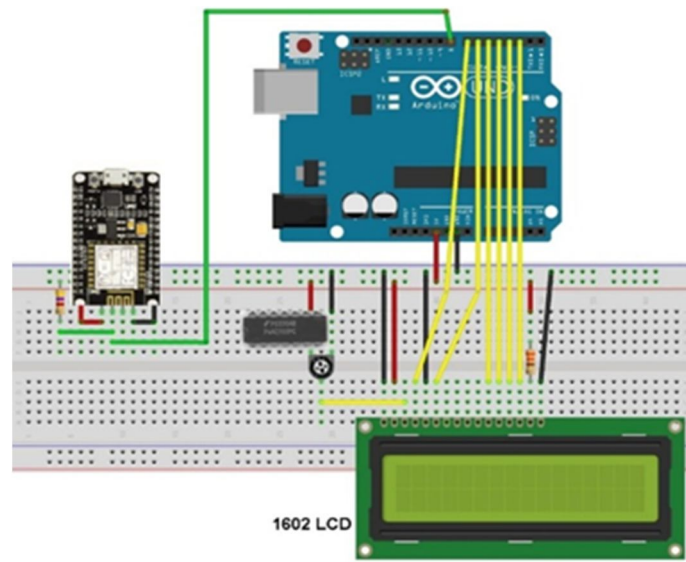


Figure 3. Circuit diagram of the hardware setup

Figure 3 depicts the E-Labs' hardware connection and integration. Due to the fact that E-Labs is used to conduct fundamental and universal gate tests, the hardware system has five separate ICs for each experiment, with matching LEDs being utilised to display the results.

III. RESULTS AND DISCUSSIONS

The hardware component of the proposed project is mostly utilised to assess the effectiveness of the experiments being carried out in the VR lab. The hardware system comprises of an Arduino Uno, a NodeMCU (Wi-Fi-Module), an LCD display (16*2), LEDs, and ICs. The LCD (liquid crystal display) and NodeMCU are both linked to the Arduino uno. In addition, connect a 10k pot's wiper (output) to pin 3 of the LCD screen, which is connected to +5V and GND. The LCD display's contrast is managed with this 10k pot. Additional inputs are provided to the IC via GPIO pins on the NodeMCU, and output is presented using LEDs. Additional LEDs are attached to the output pins of each IC. A 20000Mah electricity bank supplies the Hardware Kit with electricity. Here, five digital electronics experiments—AND, NAND, NOR, NOT, and OR—have been carried out. The user may choose the experiment they want to do and start it. Depending on the user's input, modifications will be made to the hardware model as changes are made to the virtual world.

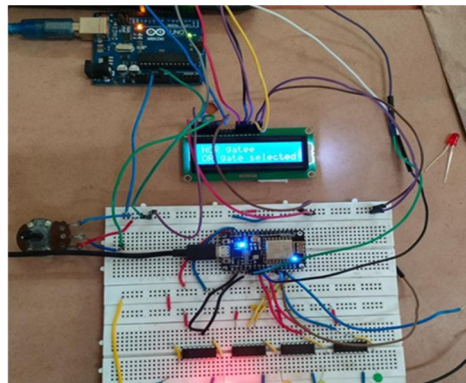
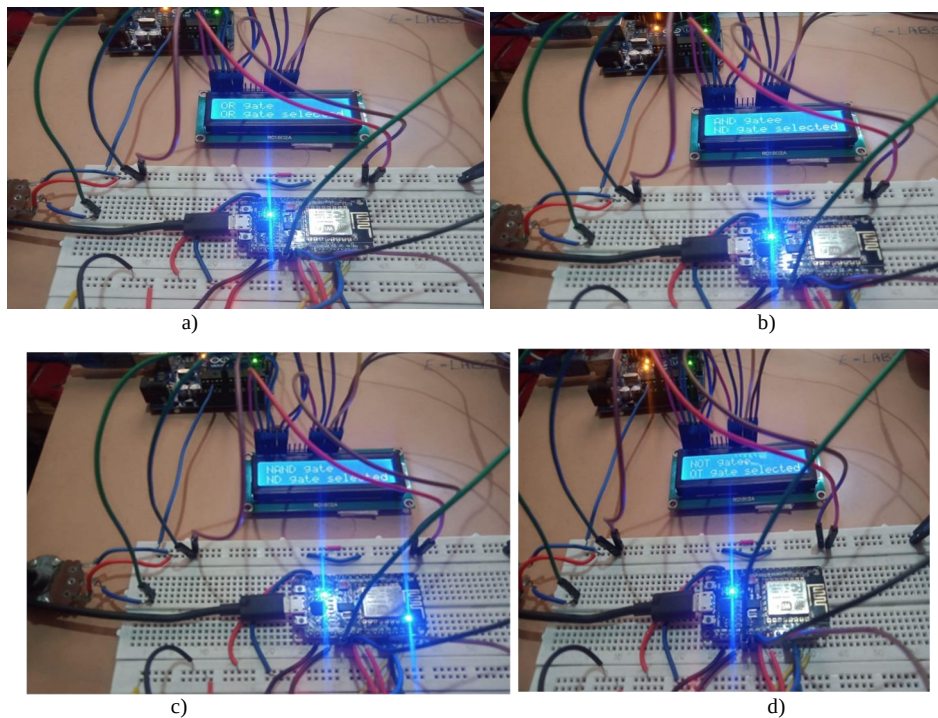
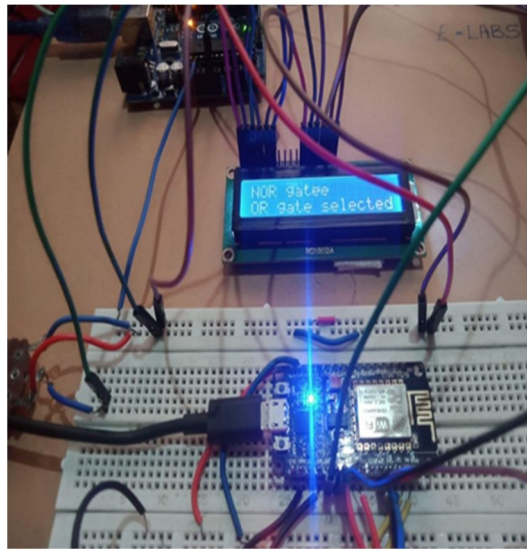


Figure 4. Hardware model of the proposed system

Hardware connections are shown in figure 4. The names of the associated experiments and gates are shown in the LCD module when various gates are chosen from the Virtual Environment. The photographs in the collection below show various experiments from the virtual environment that the virtual environment has picked up on. Figure 5 depicts the hardware system/trainer kit detecting several experiments as chosen by the virtual laboratory, as can be seen from the photographs.



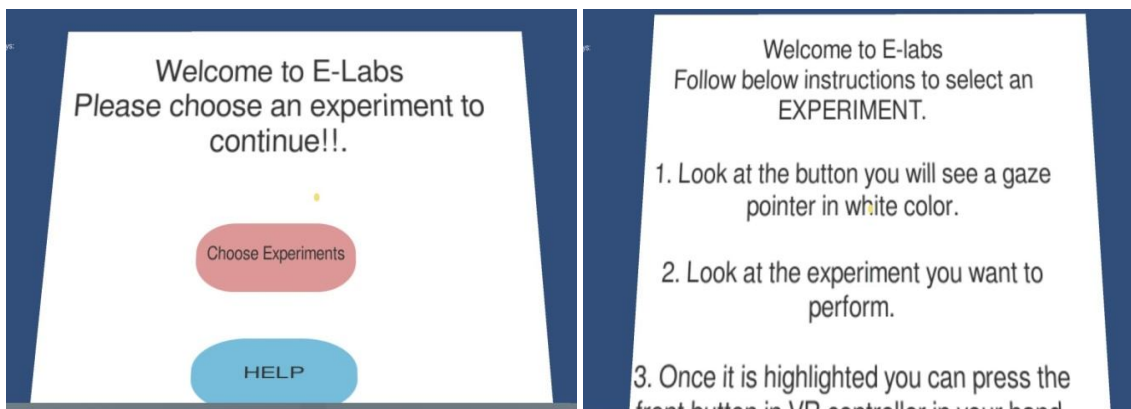


e)

Figure 5. a) OR b) AND c) NAND d) NOT e) NOR logic's implemented on the E_labs system

Building virtual environments is how the software portion of E-labs is described in the introductory section. Software called Unity3D was used to build a 3D world. The cross-platform game engine was created by Unity Technologies and is mostly used to create computer simulations and video games. The virtual laboratory was once only a single room with a table and a few components. The user using a VR headset may observe this 3D virtual lab from any angle. Integrating the virtual laboratory with the hardware system was the primary goal of the development stage. Following a successful integration, the virtual laboratory's future development was taken into consideration. A careful examination of the physical laboratory was conducted, paying particular attention to the designs of the desks, the lighting, the components set up on the tables, the room's layout, etc. This procedure provided as inspiration for the creation of a virtual laboratory that closely matches actual labs. After observation, the virtual laboratory underwent additional development to replicate the immersive experience attained in actual laboratories. The next stage of development included adjusting the lighting in the virtual lab to resemble actual conditions and modifying the characteristics of various building elements, including the walls, floors, and more, to watch how smoothly light reflected. Walls, the ceiling, and the floor all received new materials.

The user who is wearing the headset may choose things in the VR lab and interact with them by gazing at them using gaze control. After the VR lab was finished, fresh settings or sceneries were created. These were developed to enable user interactivity for the headset wearer. The user was given instructions in these situations on how to choose things using their gaze, etc. Figure 6 depicts the various cases, the UI and the experiment room in the VR lab designed using Unity3D.



a)

b)

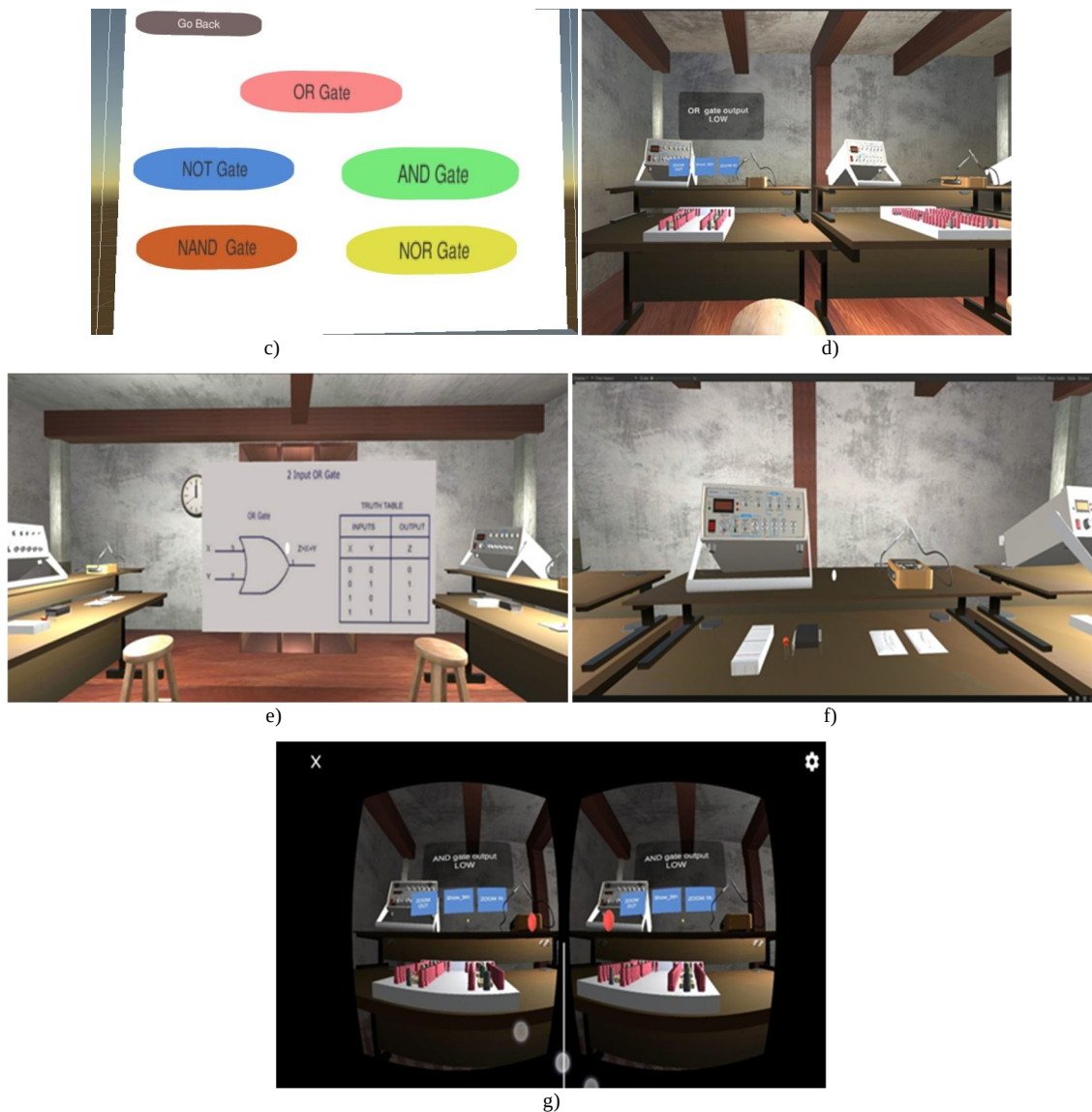


Figure 6. a) Welcome Screen b) Help Screen c) Options for the experiments d) Experiment room e) Instructions class in the f) Workbench in the VR lab g) Virtual environment visualization from the application

IV. CONCLUSIONS

The use of virtual reality in education will make experiments more visually appealing, which will make them easier for students to grasp and will spark their enthusiasm in learning new things. So let's sum up the E-Labs initiative. Due to its use of both hardware and software (Blended mode), digital electronics has a lot of potential in the educational sector and will also aid in helping students learn the concepts more quickly. The VR world will change, and those changes will also affect the hardware. Consequently, this will both provide practical information and enable students to experience visual impacts.

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