

CompVR - A Proposal of a Ludic Virtual Reality Game for Practicing Computing Concepts

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Abstract—As technology advances, schools and universities need to adapt to new computing resources in order to provide better learning experiences for their students. Virtual Reality (VR) is one of these technologies that has been gaining great prominence, since it allows to create deeply immersive and playful environments to better practice subjects that are addressed within the classroom. This work aims to present a proposal for a VR platform to practice fundamental computing concepts, since the information technology area presents itself as a sector that demands more professionals each day and lacks ludic tools to practice its concepts.

Index Terms—Virtual Reality, Education, Computing, Games.

I. INTRODUCTION

Over the years, the technology has been growing and becoming an important tool in education. Nowadays people already born in the technological environment, so the traditional teaching methods are becoming more and more obsolete. It's important to note that technology does not replace the teacher and teaching, but support the application of more interactive and dynamic solutions in order to let students more interested and motivated [1].

Among the various technologies available to assist in teaching, Virtual Reality (VR) has been gaining prominence in recent times, as it allows the user to feel like being present in certain environments, manipulating virtual objects and conducting training in situations that would not be possible due to the cost, danger or physical impossibilities. In addition, VR provides students with a greater interactivity, more contextualized material and simpler and more intuitive didactics, making learning more interesting, objective and clear [2].

The objective of this work is to present a new concept of VR tool for computing concepts practices, since the information technology area is constantly growing and does not have so many tools available to practice its concepts in a more playful and alternative way. Entitled CompVR, in its first version, the tool presents itself as a game with a playful proposal for teaching and practicing the concept of logic gates, a concept that is fundamental for computing learners. The objective is that, through this tool, students feel more motivated to present and explore concepts in the field of computing.

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The rest of this article is organized as follows: in section II, related works are presented in order to better understand the advantages of using virtual reality in teaching and how other authors have already addressed this issue. In section III, individual details of each of the technologies used in the development of this work are explored, as well as the responsibilities of each one within it. Section IV details how the first version of the developed game works, and finally, in topic V, the conclusions are presented.

II. RELATED WORK

Some authors have already explored the use of VR as an auxiliary tool for teaching and/or practicing of different types of topics. Some relevant works are presented in this section.

Freina et al. [3] proposed a scientific literature review on the advantages and potentials usage of immersive virtual reality in education. This work points that virtual reality has a great potential in education, making learning more attractive, as well as encouraging students engagement, interactivity and motivation. In addition, it shows that most of the selected works refer to university students, with an emphasis on scientific disciplines, offering opportunities to test situations that are out of reach, such as physical inaccessibility or dangerous problems.

Khairudin et al. [4] explains that using a virtual laboratory can be a good alternative for teaching digital engineering, since the learning can be realized at anytime and anywhere as long as the user has an Android device. It is known that the knowledge of digital engineering is essential for the arrival of new technologies and to face up Industrial Era 4.0, so it was developed a laboratory simulated through virtual reality where the user can visualize and interact with electronic components and circuits. According to the author, virtual labs can increase the student motivation and also save future costs.

Boonbrahm et al. [5] explained the advantages of having knowledge of digital electronics and how the elements are essential to understand how a computer works. In order to do so, digital laboratories were built to fully teach the students about these concepts so far. The authors used Augmented Reality (AR) to simulate logical ports, integrated circuits and the inputs. According to the author, the advantage of using virtual experiments is the possibility of make it anywhere,

anytime, without the bonds of a physic laboratory. The only needed device is a smartphone.

Sanches et al. [6] also proposed the use of technological resources in a ludic way for teaching electrical circuits. It is a first person VR game that works as a 3D puzzle. The game starts with the character in a scenario, which changes depending on the difficulty chosen by the player. Each scene has a proposed electrical circuit, which may contain series, parallel, mixed resistance, set of batteries and a current. When starting the phase, the proposed electrical circuit presents problems that must be corrected by the player, using the concepts of physics previously acquired in the classroom or by the game. Results obtained through quizzes showed that students approved the use of the game and the immersion offered by it helped the players to better understand some important concepts.

III. EMPLOYED TECHNOLOGIES

In order to create the proposed VR platform, different technologies and tools needed to be used and integrated. Individual details of each and their respective role in this project are briefly discussed in the following subtopics.

A. Virtual Reality

Virtual reality emerged aiming to create a new interface, mainly immersive environments, in which users can interact and visit different scenarios without having to leave their homes. This concept appeared in the 60s with the development of SketchPad by Ivan Sutherland, yet these applications became more accessible in the early 2000s. In this context, user interaction with the virtual environment is one of the most important aspects, which is related to the computer's ability to detect and react to user actions, promoting changes in the application. The more immersive and richer the virtual environment is, the greater is the users engagement and experience [7].

Currently, it is possible to use different types of VR devices for different applications, ranging from the simplest to those with more advanced features. The most powerful in terms of resources are Oculus Rift, HTC Vive and Playstation VR. However, there are other more affordable alternatives on the market that can be integrated with smartphones, such as Samsung Gear VR Oculus, VR Box and Google Cardboard. Samsung's Gear VR together with a Samsung Galaxy S7 were chosen as the devices to be used in the CompVR game, focusing in a good immersion with a great cost-benefit compared to other virtual reality devices found in the market.

B. Unity

Created by Unity Technologies, this engine allow developers to create 2D and 3D games for several platforms like computers, smartphones, and video games consoles. In addition, it employs MonoDevelop or Visual Studio Integrated Development Environments (IDE's) to build its scripts, wherein programmers can choose between UnityScript, C# or Boo

languages. For either 2D and 3D games, Unity allows to import and use external tools for speed up a game creation.

Moreover, Unity allows the development of VR content through Unity VR, providing a simple API and a lot of compatible resources for several devices [8]. Oculus Integration, for instance, is a Unity package which can be found in the Unity Asset Store and has the purpose to ease the development of VR applications. This package was used in this project and includes scripts, specific cameras, scenarios and 3D objects, as well as interfaces for the use and control of user cameras inside a VR environment [9]. Unity 3D version 2018.3.11 was employed as the main platform to integrate the modeled 3D animations with the programming mechanics. Figure 1 illustrates part of the project being developed inside the Unity IDE.

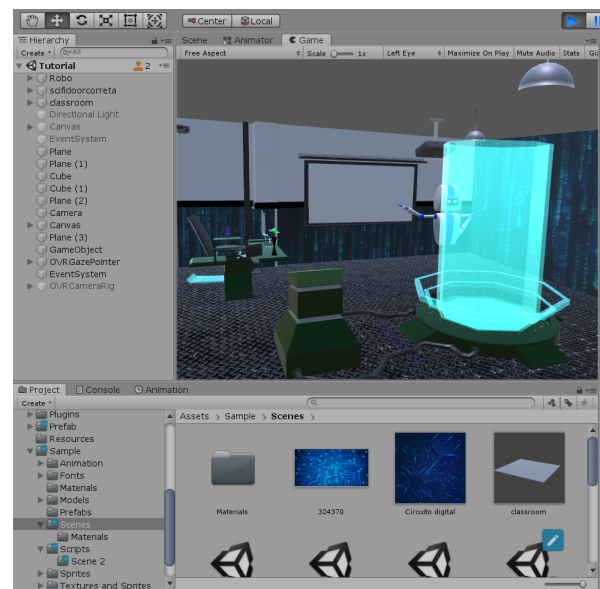


Fig. 1. Part of CompVR game environment created inside Unity

C. Blender

Blender is a free and open source cross platform tool used for modeling 3D objects, animations and video edition. In addition, it is compatible with Linux, macOS and Windows operating systems [10]. This platform allows the user to use creativity to create totally original scenarios and interactive objects, allowing to export these conceived elements to Unity 3D.

Blender version 2.79 was used to model the decorative and interactive objects of this work. Figure 2 illustrates an original 3D modeling created for this game.

IV. THE COMPVR GAME

A. Platform Construction

In order to start the development of the game, it was made a literature review followed by the definition of which platforms and technologies would be used in the project.

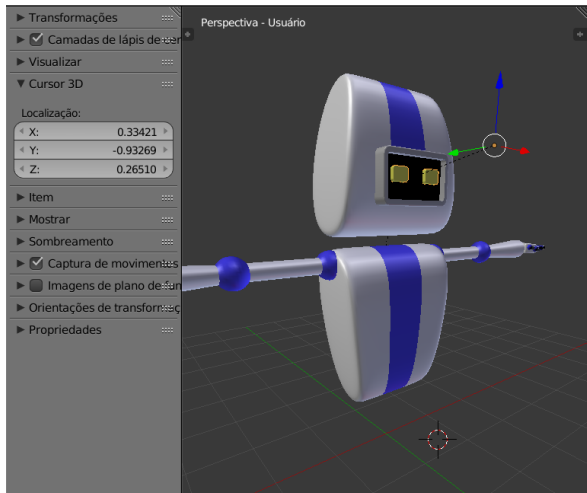


Fig. 2. A friend robot created to guide the player through the game.

The second stage was to make a brainstorm with the team in order to, based on what was studied in the literature review, create a game concept that could be attractive to information technology students. Three important factors were taken into account: create a futuristic environment once it is strongly connected to technology, give the player super powers but that are related to the computing area, and finally, also try to explore, in this first version of the game, essential concepts of computers operation.

In the third stage, the development of the project itself started with the 3D modeling part in the Blender software, where all objects such as training room, decorations, assistant robot, teleportation portal and logic gates were modeled. As soon as all previously planned objects were modeled and exported to the Unity 3D, the fourth stage started.

In the fourth stage, the animations, mechanics and interactions of the player with the scenario such as visualizing the logic gates, requesting examples of inputs, outputs and visualization examples of logical combinations were built. After the development of the training room, it was started the creation and animation of the logic in the real missions stages, such as the correct and incorrect positioning of the logic gates in the proposed logic circuits.

Once the first game prototype was ready, the fifth stage, i.e., the integration with virtual reality began. All changes of cameras, collisions with objects and configurations were made through the Oculus Integration library, which allows the game to become an application compatible with Samsung Gear VR device.

In the sixth and last stage, several tests were done to repair errors and bugs in the game prototype.

B. Story

In CompVR, the player plays the role of a character in a futuristic world, in which lots of computers are malfunctioning. However, he discovers that he has the power to enter computer systems to solve some kinds of computational

problems. Before being sent to the mission, the player with the help of a friend robot undergoes a series of training sessions, in which the concepts of logic gates, their respective truth tables and examples of combinations are presented.

After the tutorial, the character is teleported to the stages where he will face “real” challenges, in which several different combinations of logic gates will be presented with their respective incomplete inputs and outputs in which the player must fix.

C. Mechanics

When starting the game, the player have the menu screen, which is composed of 3 button options as depicted by Figure 3. The first one (Start) is used to commence the game. To complete the objective, it is necessary to go through a tutorial phase, in which the concepts and logic gates, their respective truth tables and some combinations will be presented. From there, the player will be able to interact with 3 buttons (next, back and example), which are used to proceed, go back and see examples of inputs and outputs. This step is showed in Figure 4.



Fig. 3. Game Menu



Fig. 4. Game Training Tutorial

After the tutorial, the player is sent to real missions inside the game, in which he has to choose the correct logic gates to be inserted in the empty field of corrupted logic combinations, as illustrated by Figure 5. The more he hits, the more points will be accumulated. In these challenges will be presented

several combinations and two options of logic gates to be chosen by the player. The logic gates are represented by buttons, in addition to the proceed button.

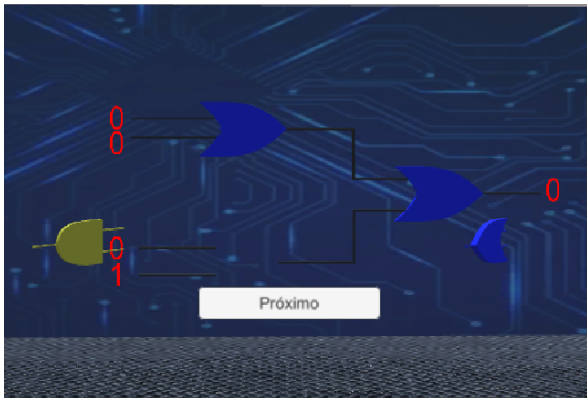


Fig. 5. Example of real mission inside the Game

In order to select the logical gate, the user uses the head movement and the aid of a joystick to click on it. If it is correct, the player wins 10 points (as shown in Figure 6) and if it is wrong, he loses 5 points. After a set of four stages, a partial score is presented and then the player is sent to a new set of more difficult missions.



Fig. 6. Message presented to the player when he selects a correct port to recover the circuit.

V. CONCLUSIONS

With the advent and popularization of some technologies, mastering them to support students in the learning process becomes something essential nowadays in order to offer better learning experiences.

During the first stage of this project, which started with a general research, it was possible to observe how games and playful tools can be a powerful help to assist teachers and educators in the teaching process, since it makes the learning process more practical and pleasant to the students.

Among the uncountable ways to offer these activities, comes the VR experiences, an opportunity to bring the students to a completely virtual world where creativity and knowledge can be mixed without boundaries to create immersive experiences.

Despite the use of games and their advantages in education have been explored for some years now, during the researches it was possible to realize that there are not so many VR platforms to this end. Therefore, it was a point that motivated the creation of this proposed work, that has the goal to become a platform to practice computing concepts fundamentals.

Some challenges appeared during the concept and creation of the project. The first one was to better understand which VR device could be chosen. As the intention of this project is to run in a cost-benefit device and the software itself be free of charge, the creators decided to use the Samsung Gear VR by Oculus, once it meets the cost-benefit requirement and is compatible with many smartphones of the brand. However, once the application runs in a smartphone, extra attention was necessary to model the 3D objects in order to create them with as few polygons as possible, but without losing its identity.

Even though this first version of the game met its creators expectations, there are some important future work to be done. Starting with the addition of new kinds of fundamental computing concepts to be practice inside the platform, such as the best understanding and use of electronic components, computer architecture and even basic notions of programming. Another important step to be done is measuring how much the platform can help in the learning process once it is applied in a real teaching environment.

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