Augmented Reality - A Tool to Support Learning in Engineering Schools. Automation Practice Case

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Abstract. Augmented reality is a technology that improves user experiences by allowing digital sensations to be integrated. While virtual reality is an immersive model based on simulated environments using glasses, these simulated environments are built through a server. Everything that the user can see or feel is artificially provoked through images and sounds. Both realities are technological tools that are adapted to the professional development of engineering learning, which have been of significant help during mobility challenges due to the global pandemic. Although virtual and augmented reality are expensive to implement in some countries, there are still opportunities to implement them by giving access to new learning tools and creating opportunities to develop learning even in times of challenges of learning due to separation and distance. This article collects information about virtual reality and augmented reality, both of which have been applied with remarkable success in America and Europe, as well as to propose these means as a learning tool to be used in the automation laboratory of engineering schools, using augmented reality techniques to support and improve the competences necessary for distance education in times of epidemic. The method applied was based on the observation of students from a high grade level as qualitative research, the results will support parallel research to include immersing reality.

Keywords: Virtual reality · Augmented reality · Distance learning · Automation

1 Introduction

There has currently been a significant delay in education globally, affected by the closure of schools at all levels and the economic recession due to measures to control the epidemic. In the last update at the end of April, the closure of schools in 180 countries was detected, causing 85% of students worldwide to be unable to attend schools [1]. Having school closings creates a delay and losses in learning in the case of engineering, since there is no access to schools for face-to-face classes, there is no access to laboratories and practices which are essential in the engineering area since they provide the possibility to understand and corroborate the hypotheses proposed in the scientific field.

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As a learning tool, it is currently sought to implement virtual reality and augmented reality in the automation area to be able to observe in a three-dimensional way and remotely access activities that cannot be felt in person [2].

Virtual reality seeks to recreate the reality in which we live through digital-based interactions. In the words of Memarsadeghi & Varshney [3] "virtual reality (VR) recreates the sensory world around us entirely through computer-generated signals of sight, sound, touch (and in some cases smell and taste)" in other words, it separates us from the reality to a high immersive experience on a digital created world in which we perceive the sensations as if it were real.

Therefore, augmented reality broadens the perception of what reality looks like through virtual technology. It is a technology that helps us and allows us to expand extra information to images when they are viewed on a device. Combining virtual and physical elements [4, 5].

On the other hand, automation is based on computer science, mechanics, and electromechanical processes that become functional with minimal human involvement. They help to optimize the operation of different processes and products [6]. Authors like Carrillo &Vásquez [7] define it as the reduction of labor and use of the necessary resources without wasting them. And the application of mechanical and electronic systems and computer bases to operate and control production. While it also can be described as a set of techniques associated with the application of mechanical/electronic systems and based on computers, whose objective is the operation and control of production.

Analyzing the different conceptual points of view on automation, we finally define automation as a system that, with the help of technology and command orders, reduces the use of labor resources. Avoiding a waste of costs and time, increasing the quality [8].

The face-to-face laboratories in this type of class are of the utmost importance since it is vital to be able to carry out physical tests to support your hypotheses. Many higher education institutions seek to implement vital strategies in times of pandemic, using virtual classroom models seeking greater participation and understanding of the exposed topics [9].

Currently there has been an increase in this type of virtual classroom, since they present greater accessibility and flexibility with the use of multiple devices, allowing similar experiences to be covered with virtual and augmented reality.

With these virtual experiences, it can be corroborated that by carrying them out, the need for high investments is reduced by substituting those infrastructures with easy-to-use tools, devices, and applications, giving greater access to the education sector, providing the same experiences virtually as in person. The virtual reality structures provide the student with learning tools and experiences that promote the exploration of information from real data in virtual media. [10, 11].

There have been cases in which the MR (Mix Reality) to learning processes in factories has been studied [12]. The conclusion reached is that the use of this technology extends the opportunities for learning significantly. It is well known that physicality of learning, and thus their connection to hardware, is the cornerstone for effective learning. While virtual environments on the other hand have a high degree of flexibility and are quickly adaptable, they are not bound by physical hardware. This allows learners to experience processes, methods and scenarios that are not available through conventional means. Combining the advantages of the real and virtual world unlocks enormous potential for enhancing learning successes. Other [13] authors have corroborated with the previously mentioned conclusions. They have conducted researched on the different areas where these technologies can be used, leading to the conclusion that the AR (Augmented Reality) technology shows a better use for the learning phase.

2 Methodology

This work was based on qualitative research that starts from documentary research, based on related articles, educational links books and didactic material used at the engineering school.

It is informative in nature because it shows valuable information and research on virtual and augmented reality. And on how these technologies are applied in the different learning styles in higher education in the engineering area.

Diverse sources were used for the research of useful teaching material on automatization topic, among which are:

– Printed documentation: books, research projects, case studies.
– Electronic documentation: materials found on the internet, such as books, specialized magazines and articles that are published in digital format.
– Audiovisual documentation: Videos and audios that contain information from interviews, presentations, and conferences.

After extensive research based on the hardware and software necessary to develop this application the ones mentioned below were selected:

– Unity: The version of unity used to develop the app was version 2018.4.15f1, for this to work it was necessary to use other add-ons like Vuforia and Visual Studio.
– Visual Studio: A programming IDE used to compile and to correct the functionality of Unity.
– Vuforia: An add-on used with Unity to create the markers and to implement the basic AR interactions for the app.
– Laptop: This device was used to run Unity with the minimum requirements.
– Smartphone: The smartphone used to run this app which had Android system API 19 (4.4 - KitKat) which is the minimum to run Vuforia and AR apps.
– Solidworks: The 3d models shown in the app were created using this software, they were chosen based on previous knowledge and experience used in the regular practices and how the students interacted with them.

Augmented reality was applied in laboratory practices related to automation through the developed application called ARLAB (Augmented Reality Laboratory) which a group of 30 students used to develop their experiments (See Fig. 1). Application of practical material was compared with theoretical material to support the theories and interpretations. A satisfaction survey was used based on Likert scale with two questions, the first one asking how much they liked the app and the second one asking about how easy it was to understand.

Fig. 1. Example of the app running during implementation in laboratory practices.

Practice one consisted of the student knowing the compact and modular PLC, which was presented by means of a QR code created using Vuforia packages (See Fig. 2), when pointing at the target, it showed the PLC 3D model allowing the students to disassemble its modules, just by dragging them to another location in the screen of their smartphones, successfully meeting the requirements of the educational program without having to attend their corresponding classes in person (See Fig. 3).

Fig. 2. QR code used.

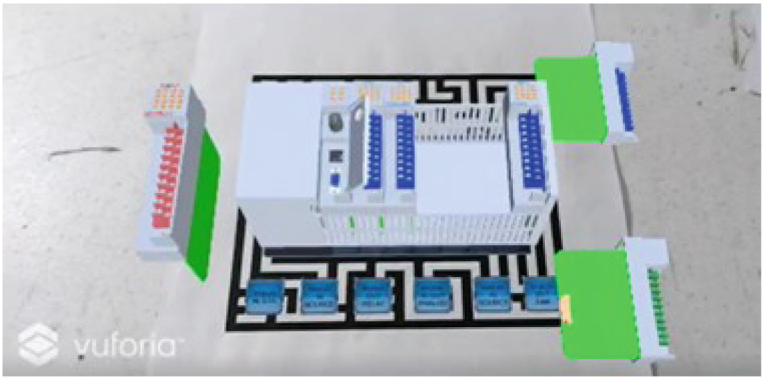


Fig. 3. Modular PLC 3D model showed.

In the second practice, in the same way as in the first, we worked with a modular and compact PLC, the applicable difference in this case was the information displayed (See Fig. 4), the student had to select the desired PLC.

Fig. 4. PLC selection screen in the app.

After the selection of the desired PLC (See Fig. 5), the student, in addition to viewing the modular PLC, was able to look at theoretical information such as the I/O distribution, voltage necessary to make it work and some other technical information about the selected model.

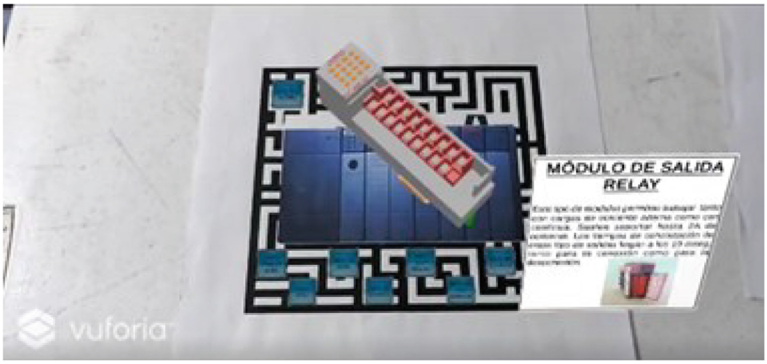


Fig. 5. Modular PLC information displayed.

For practice three, the students were asked to turn on different lights by means of a sensor connected to the PLC, which, thanks to augmented reality, was possible (See Fig. 6). The only thing that the student had to do was place his finger or hand under the sensor covering the QR code to turn on the lights.

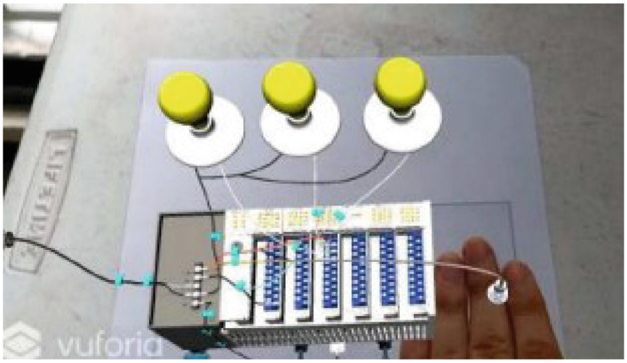


Fig. 6. Sensor and lamp connections.

Each time the students progressed with respect to their automation practices, the students were presented with a more detailed and advanced augmented reality case to be able to successfully develop what was requested. For these previous practices, the student just pointed at one marker at a time, once they became familiarized with this type of interaction, the students were asked to use more than one marker.

One case is practice four, which included a video tutorial so that the student could download different software which would make him capable of programming PLCs by augmented reality, the students just needed to touch the play icon in the GUI at the screen, to play the video, as a support the video was also provided to the students through a URL and shown during theoretical class (See Fig. 7).

The next step to perform consisted of placing the target image (QR code) in front of the camera, according to what section of the PLC they wanted to visualize. It should be noted that tutorial videos were reproduced by the augmented reality view, giving access to a more advanced type of visualization (See Fig. 8).

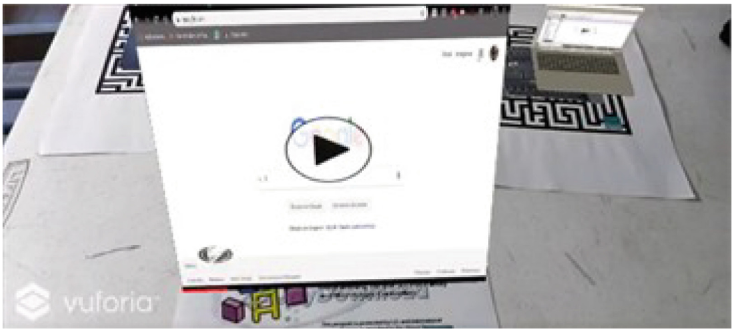
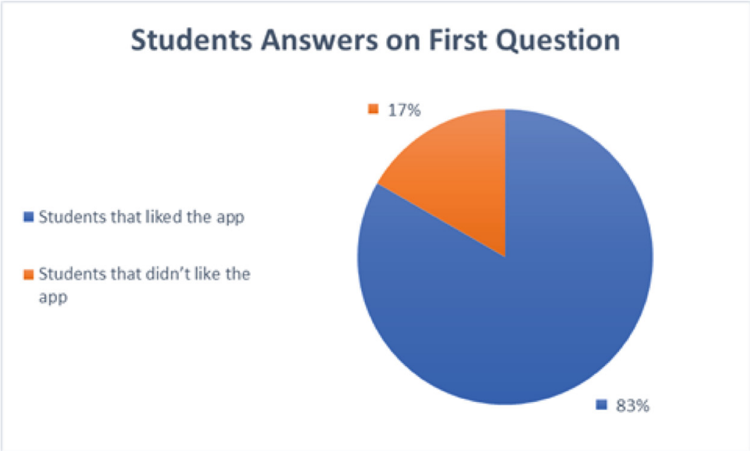


Fig. 7. AR view of the tutorial.

Fig. 8. Practical augmented reality view 4.

3 Results

After the use of this application in a group of 30 students, it was found that most of them believed this method to be more attractive and easier to understand than using the conventional method of showing the students the physical PLC. Also, the risk for the equipment to be damaged due to inadequate connections was avoided (See Fig. 9). This app was developed to be applied on future projects in order to analyze the usability of AR applications and the student's level of achievement during their study sessions.



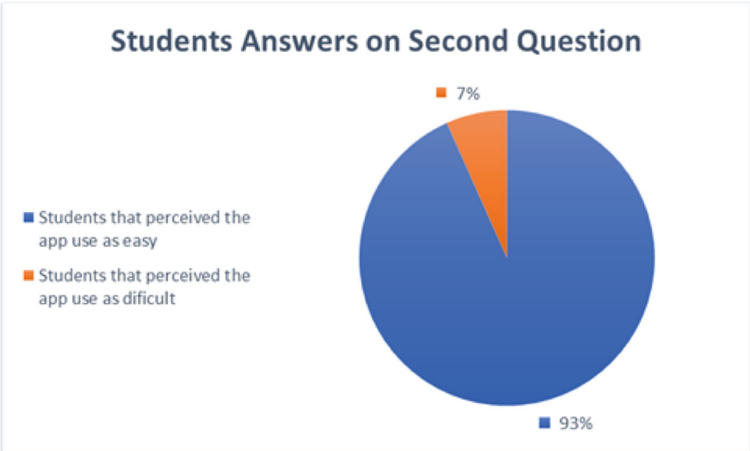


Fig. 9. Pie Chart showing the students answers to both questions asked in the survey.

Developing automation labs with augmented reality allows high school students and other educational levels access to additional tools by meeting their needs and implementing them in classrooms. The exception here is that during the pandemic, all the faculties and universities had been facing problems related to the restrictions of student access to the facilities. This tool was developed thinking of a hybrid educational plan on which the students will not be affected if they cannot attend their normal classes.

4 Discussion

Observing the obtained results, we noticed that the practices were carried out in a satisfactory way, where the student was able to see, perform, learn, and interact in a much more visual and effective way than just reading the theory and trying to understand the topics seen. In light of the uncertainty being experienced worldwide, this application is an extra tool that complements all the practices seen during the sessions of the online modality and we are convinced that it is an advance for aspiring engineers to have adequate training and not leave the issues seen unfinished, but all the practices to be done [14, 15]. It will ensure that a university level education be more independent of global inconsistencies.

It is also important to note that our tool, although it has only been applied in the automation area, is possible that in the future it will be used for many other subjects and practices of university colleagues [16].

5 Conclusion

To conclude with all the information that we have obtained so far, we clearly see that the implementation of augmented reality is necessary so that students can enjoy better-quality learning during times of unforeseen changes, Taking advantage of the online modality that is common today due to the pandemic would still remain in force at the UANL, as well as continuing with the visual aids and especially with the practices that are most useful if they are carried out interactively. Although the program continues to function in a stable way with the traditional class method, with the augmented reality, sessions would be complemented, inspiring more imaginative conceptual thinking, and knowledge would be better assimilated [17].

With all the results obtained, it should be noted that augmented reality was already in great development and was already being implemented in different universities around the world. With the pandemic came a new stage of education where it was no longer optional to acquire knowledge from a distance but became a necessity where students from their homes continued with their purpose of graduating as engineers while restricted. For that, augmented reality became a great ally that has had very positive results. It can continue to be part of the daily program post-pandemic in the Face-to-face modality. Some classrooms will have to be adapted for the implementation of an academic program that has augmented reality in it [18, 19].

All the information and results obtained have been very satisfactory for us who are engineering students, since it allows us to see a different panorama of how we perceive knowledge and we are utterly convinced that it is a particularly useful tool and a great complement in learning engineering. The greatest learning tool is experience, which is provided by use of this technology. We know that it will be of significant help to future generations who will be able to take advantage of this form of learning. It is also important to mention that its implementation will be a gradual step-by-step and can be adapted immediately to our needs today [20].

Finally, we would like to thank the Faculty of Mechanical and Electrical Engineering that allowed us to develop this project, which with this article and its application has a great positive impact and continues to innovate the way we acquire knowledge and that it always progresses to be of Best Quality [21].

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