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ANALYSIS OF VIRTUAL REALITY IN THE WORKSHOP CLASSROOM: A CONTRIBUTION TO TECHNOLOGICAL PRACTICES FOR STUDENT TRAINING IN CONALEP AND TECNM CAMPUS VERACRUZ

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Abstract: Traditional practices in technological subjects at technical schools and universities often follow similar methods. In this context, an innovative project has been implemented using virtual reality (VR) glasses to improve technological practices in the classroom. This project focuses on creating augmented reality (AR) environments that facilitate the understanding and application of advanced technological concepts. Using existing equipment and resources available at the institution, interactive simulations have been developed that allow students to experiment and practice in a safe and controlled environment. This approach not only optimizes practical learning, but also encourages the reuse of equipment and technological resources, thus contributing to their more sustainable use. Students of electronic, electrical and mechatronic engineering, among other disciplines, benefit from these improved practices, developing key competencies in a more immersive and effective way.
Keywords: Virtual reality, Augmented reality, Educational simulator, Technological practices, Educational innovation.

INTRODUCTION

Technology education in engineering and technical schools constantly faces the challenge of staying current with the demands of modern industry. The growing need to improve productivity in various sectors has brought to the fore the importance of industrial process automation. In this context, the use of emerging technologies such as virtual reality (VR) (see Figure 1, where a student practices in VR) and augmented reality (AR) in the educational field offers a unique opportunity to prepare students. students more effectively.

Figure 1: Student doing practice in VR.

In the theoretical framework of this project, it is explored how VR and AR environments can be integrated into technological practices to simulate complex processes in a more intuitive and accessible way. This approach not only makes it easier to understand advanced technical concepts, but also allows for an immersive and hands-on learning experience.

The project focuses on the development and implementation of interactive simulations, as can be seen in Figure 2, that replicate real industrial environments, using equipment and resources available at the institution. These simulations allow students to experiment with automated systems in a safe and controlled environment, where they can design, analyze and maintain these systems without the risks associated with real machinery.

Figure 2: Teacher explaining electrical installations.

The VR glasses and AR environments provide an innovative platform for technical career students to develop essential competencies in the field of; electronic, electrical and mechatronics. Likewise, this technology allows high-tech equipment to be available to students of Electrical, Electronic, Mechatronics and Renewable Energy Engineering. Through these tools, students can visualize and manipulate virtual elements, enriching their learning and providing them with a deeper and more practical understanding of automated systems.

This educational approach not only promotes more effective learning, but also encourages the reuse of technological equipment and resources, contributing to their more sustainable use. The integration of VR and AR into technology practices (Figure 3, Engine Class in AR) represents a significant step toward modernizing technical education, preparing students to meet the industry challenges of the future.

GENERAL OBJECTIVE

The overall objective of this research has been to demonstrate that the use of virtual reality glasses and the creation of augmented reality environments can significantly improve technological practices in both a technical and engineering school. By implementing these technologies, the aim is to provide students with an innovative tool that allows them to carry out various practices in a more interactive and effective way, while encouraging the reuse of existing equipment and promoting a sustainable approach in technical education.

Figure 3: Class of engines in AR

SPECIFIC OBJECTIVES

- Develop augmented reality environments: Create interactive simulations and virtual environments that represent real industrial processes, where students can apply their knowledge in a practical and safe way.

- Foster practical skills: Facilitate the development of key technical skills in students, allowing them to experiment and solve problems in a controlled environment that simulates real industrial conditions.

- Integrate sustainable technology: Use recycled equipment and existing resources in the institution to create augmented reality environments, reducing costs and promoting the reuse of technological materials.

- Enrich the curriculum: Complement the curriculum of the technical careers in Refrigeration and Air Conditioning, Mechatronics and bachelor's degree study programs in Electrical Engineering, Electronics Engineering, Mechatronics Engineering and Renewable Energy Engineering. Providing an additional tool that enriches students' learning and preparation for the challenges of the world of work.

- Innovation in technical education: Promote the modernization of technical education by incorporating advanced technologies such as virtual and augmented reality, thus improving the quality of training and preparation of future professionals.

HISTORICAL EVOLUTION OF VIRTUAL REALITY

Virtual reality (VR) has undergone a significant evolution since its inception to become an advanced tool in education and industry. Although the basic concepts of virtual reality can be traced back to the imagination of visionaries like Morton Heilig, who in 1962 invented the Sensorama, a device that combined stereoscopic images, sound, vibrations and smells to create a multi-sensory experience, the true evolution of VR began to gain momentum in the second half of the 20th century.

In the 1960s, Ivan Sutherland developed the first virtual reality headset, known as "The Sword of Damocles." This rudimentary, although innovative, device required a suspension system due to its weight and size. Technological evolution continued in the 1980s with the company VPL Research, founded by Jaron Lanier, who popularized terms such as "virtual reality" and developed equipment such as gloves and data helmets.

The 1990s saw major advancements with the introduction of more accessible VR systems, such as Virtuality, a gaming platform that used 3D headsets and gaming stations. However, the technology still faced significant limitations in terms of resolution, processing capacity and latency, restricting its use to specific niches and industrial applications.

The real rise of VR began in the 2010s with the development of more advanced and accessible devices. The appearance of the Oculus Rift in 2012, thanks to a crowdfunding campaign, marked a turning point. This device offered an unprecedented immersive experience and spurred renewed interest and rapid evolution in VR technology. Other companies such as HTC with its Vive and Sony with its PlayStation VR also helped popularize VR in the consumer market.

Today, virtual reality has been integrated into various fields beyond entertainment, including medicine, military training, architecture and, of course, education. In education, VR is used to create immersive learning environments that allow students to interact with complex simulations and visualize abstract concepts in a tangible way. This has transformed the way technical and scientific disciplines are taught, offering hands-on experiences without the risks and costs associated with physical equipment.

The evolution of VR continues, driven by advances in technologies such as eye tracking, improved screen resolutions, and the integration of artificial intelligence to create even more interactive and realistic environments. These innovations promise to continue expanding the applications of VR and its impact in various industries, making virtual reality an essential tool in the training of future professionals and in the improvement of industrial and educational processes.

DEFINITION OF VIRTUAL REALITY (VR)

Virtual reality (VR) is defined as a technology that uses computing devices to create simulated environments in which users can interact in an immersive manner. These environments can replicate real-world situations or create completely fictional scenarios, providing a multi-sensory experience that includes 3D viewing, surround sound, and sometimes haptic feedback. VR is used in a variety of fields, from entertainment and education to medicine and industry, allowing users to experiment and practice in situations that would be difficult or impossible to recreate in the physical world.

GENERIC FUNCTIONS OF VIRTUAL REALITY IN TECHNICAL EDUCATION

SIMULATION OF INDUSTRIAL ENVIRONMENTS

The VR allows the creation of simulations of complex industrial environments, where students can interact with machinery and processes in a safe and controlled manner.

Figure 4: Induction motor in Augmented Reality.

VISUALIZATION OF ABSTRACT PROCESSES

The students can visualize technical and scientific processes that are difficult to understand with theory alone, such as the flow of magnetic fields that produce electricity in a circuit or the internal structure of a machine; As an example, you can see figure 4: in "Augmented Reality" in an Induction Motor.

- Practical interaction: VR offers the possibility of carrying out technical practices without the need for physical equipment, which reduces costs and risks associated with the use of real machinery.
- Real-time training: Students can practice procedures in real time, improving knowledge retention and practical skill acquisition.
- Immersion and focus: The immersive VR experience helps students focus and stay engaged in learning, increasing educational effectiveness.
- Immediate feedback: VR environments can provide immediate feedback, helping students correct errors and continually improve their skills.

GENERAL CHARACTERISTICS OF VIRTUAL REALITY

- Complete Immersion: VR provides an immersive experience that makes users feel like they are truly present in the virtual environment.
- Interactivity: Users can interact with objects and elements within the virtual environment, facilitating practical and dynamic learning.
- Personalization and Adaptability: VR programs can be customized to meet specific student needs or educational goals.
- Ease of use: VR interfaces are designed to be intuitive and accessible, allowing even those with little technical experience to use them with ease.
- Program portability: Virtual environments and simulations can be easily saved and reused, allowing repeated use for different groups of students.
- Compatibility with various technologies: VR can be integrated with other educational technologies and devices, such as motion sensors and haptic controls, to further enrich the learning experience.

FIELDS OF APPLICATION OF VIRTUAL REALITY

Virtual reality (VR) has a wide range of applications due to its flexibility and ability to create immersive and highly interactive environments. The question that arises is: When must virtual reality be implemented in an educational institution or in an industry? The answer, although quite extensive, can be summarized by saying that VR will be suitable, or even become an optimal solution, in the following contexts:

Education and technical training: VR is ideal for educational environments where complex technological and technical practices are required. Its ability to simulate industrial and laboratory scenarios allows students to experiment and learn without the risks associated with handling real equipment as seen in Figure 5: Safe practices in industrial environments. This is especially useful in technical schools and universities where practical training is crucial.

Figure 5: Safe practices in industrial environments.

Training in safety procedures: In industries where safety is paramount, VR allows workers to train in risky situations without exposing themselves to real dangers. Emergency simulations, heavy machinery operation, and evacuation protocols are some of the areas where VR can be extremely useful.

Design and prototyping processes: VR allows engineers and designers to visualize and manipulate 3D models before physical manufacturing as shown in Figure 6. This makes it easier to detect errors and optimize designs, reducing costs and development time.

Figure 6: 3D Model of Turbocharger.

Simulation of industrial processes: For industries with sequential or variable processes, VR provides an effective tool for planning, controlling and optimizing these processes. Workers can interact with production line simulations, learn to operate new machines, and better understand workflows without disrupting real production.

Medicine and Rehabilitation: In the medical field, VR is used for training surgeons, simulations of medical procedures, and rehabilitation programs for patients. The ability to create controlled, personalized environments makes VR a valuable tool for improving skills and recovery.

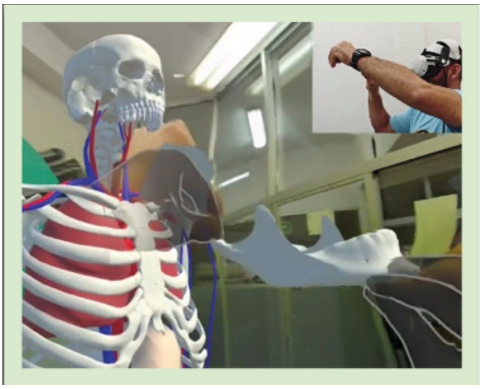

Figure 7: A doctor explaining the jaw joint in RA

Figure 8: Explanation of heart valves in RA

Marketing and sales: VR experiences allow companies to offer their customers interactive demonstrations of products and services. This is particularly effective in sectors such as real estate, where clients can virtually tour properties before construction or purchase.

Implementing virtual reality offers numerous benefits, from reducing risks and costs to improving training and design efficiencies. Its ability to create detailed and realistic environments makes it an indispensable tool in many fields, providing innovative and effective solutions to current challenges.

VIRTUAL REALITY (VR) CLASSIFICATION

Virtual reality (VR) is classified into different categories based on various criteria, such as level of immersion, technological complexity, mobility, and specific application. Below is a detailed classification of the different forms of commercially available VR and their distinctive characteristics:

NON-IMMERSIVE VIRTUAL REALITY

Description: This form of VR does not provide complete immersion in a virtual environment. Instead, it is presented on a standard screen, such as that of a computer or mobile device.

Applications: Primarily used in simple simulations and computer games, as well as some educational and training applications where full immersion is not necessary.

Examples: Simulation games such as "The Sims", basic flight simulators, and certain interactive educational programs.

SEMI-IMMERSIVE VIRTUAL REALITY

Description: Offers a more immersive experience than non-immersive, using large screens or projectors to create a wider field of view. However, it does not use virtual reality headsets.

Applications: Common in training simulators for pilots and drivers, as well as in some educational experiences and interactive museums.

Examples: Advanced flight simulators, driver training systems, and interactive museum exhibits.

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FULLY IMMERSIVE VIRTUAL REALITY

Description: Uses virtual reality headsets (HMDs) to provide a completely immersive experience. Users feel like they are inside the virtual environment, thanks to stereoscopic 3D viewing, surround sound, and often haptic feedback.

Applications: Games, vocational training, advanced education, military simulations, and medical treatments.

Examples: Oculus Rift, HTC Vive, PlayStation VR, and military training systems that use VR environments to simulate combat scenarios.

MOBILE VIRTUAL REALITY

Description: Uses mobile devices (smartphones) inserted into specific VR headsets (such as Google Cardboard or Samsung Gear VR) to provide a more accessible, portable VR experience.

Applications: Mobile games, educational experiences, virtual tours, and interactive marketing.

Examples: Google Cardboard, Samsung Gear VR, and Oculus Go.

HIGH FIDELITY VIRTUAL REALITY

Description: Provides the highest possible visual and interaction quality, using powerful computing systems and high-end equipment. These systems can include full-body motion tracking and advanced haptic feedback.

Applications: Industrial simulations, medical and surgical training, high-tech product development, and high-end entertainment experiences.

Examples: VR systems used in the automotive industry for design and testing, advanced surgical simulators, and virtual reality theme parks.

LOCATION-BASED VIRTUAL REALITY (LBVR)

Description: VR experiences designed to be used in specific locations, such as theme parks, VR arcades, and entertainment centers.

Applications: Multiplayer games, theme park attractions, adventure simulations, and interactive events.

Examples: The Void, Zero Latency, and VR experiences at Disney parks and Universal Studios.

VIRTUAL REALITY RANKING FACTORS

IMMERSION LEVEL:

Immersion can range from flat screen displays to fully immersive environments using VR headsets and advanced motion tracking technologies.

TECHNOLOGICAL COMPLEXITY:

It involves the sophistication of hardware and software, including processing capacity, graphic quality, and the accuracy of motion sensors.

MOBILITY:

VR can be fixed (requires stationary equipment such as powerful PCs and tracking cameras) or mobile (uses portable devices such as smartphones).

SPECIFIC APPLICATION:

Applications can range widely from entertainment and education to industrial simulations and medical treatments.

CONCLUSIONS

This research has explored the feasibility and potential of using virtual reality (VR) as an educational tool in the field of engineering and other technical disciplines. It highlights how it is possible to create virtual teaching environments step by step, using mainly recycled and low-cost materials, demonstrating that the implementation of VR in technical education is accessible and feasible even with limited resources.

By creating virtual educational environments, students have the opportunity to develop skills in various fields, including welding, structural mechanics, and programmable logic control, among others, as well as strengthen their knowledge in the field of electronics. VR offers an immersive and hands-on learning experience that complements and enriches traditional classroom training.

It is important to highlight that the main benefit falls on the student, who not only acquires specific technical skills, but also learns the value of collaborative work, problem solving, creativity in the design and implementation of projects. The responsibility for the success of the project falls largely on the student, who must demonstrate initiative and commitment to achieve the proposed objectives.

Although the prototype presented as a result of this research fulfills its purpose, it is important to recognize that there is always room for improvement. The structural flexibility of VR allows virtual environments to be adapted to simulate a wide range of learning situations and scenarios, expanding its usefulness and versatility in technical education.

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