Augmented Reality in Robotics Learning

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ABSTRACT

The objective of the research is to determine the impact of an application with augmented reality in the robotics-oriented teaching-learning process. The research has a quantitative and exploratory, descriptive, and explanatory approach. The study population was made up of 30 students subdivided into two groups: experimental and control. A pre-test was applied to all study participants as a starting point, to later carry out the intervention with the application of augmented reality for the experimental group, and for the control group with pedagogical cards. A comparative analysis was carried out with the results of a posttest applied to both groups. The study topic covered in five stages was the same for both groups under a constructivist approach. The results obtained show that the use of a technological tool with augmented reality has a favorable impact on the teaching-learning process of Robotics. It was also observed that the group of students who used the app were motivated and developed their research skills, achieving significant learning.

Keywords: Teaching-learning process, Industrial Robotics, Augmented Reality.

INTRODUCTION

At present, education and society demand entities with creative and entrepreneurial skills with the implementation of the use of technological tools in the teaching-learning process such as in (Zapata, M and Polo-Mantuano, 2021). For proper learning, a methodological process that links theory and practice must be considered, developing, in this way, in the student, knowing-how, that is, with the application of techniques and knowledge that allow them to undertake an activity in which their skills are reflected (Pillajo and Zapata, 2021).

In this context, ICTs (Information and Communication Technologies) allow the development of thinking skills, collaborative, cooperative and communicative learning spaces, which contribute to the transformation in different ways of teaching and learning. Thus, the development of ICTs has driven the need for changes in the curricular and pedagogical design that motivates teachers to acquire new skills, allowing them to create didactic materials in digital environments that improve the quality of student learning, including Augmented Reality (AR) and Virtual Reality (VR) applications. These immersion systems have been shown to stir up teaching-learning processes in classrooms, making it easier for students to manipulate 3D objects (Teneda et al. 2021). In the field of industrial technical study, virtual environments allow users to operate industrial plants allowing the administration, training, production systems animation (Rivera et al. 2021), simulating environments that can hardly be obtained in real media such as robotic and mechanical systems, machine handling simulators, etc. (Andaluz et al. 2019).

Industrial Robotics achieves the future for the development of industries in auto-matic processes, therefore, emphasis is given to its study at secondary levels in tech-nical specialties (Herrera et al. 2019). In certain cases, their study is limited due to the lack of financial resources that imply the acquisition of a manipulator, so the use of simulators or immersive systems that allow interaction through three-dimensional models, facilitate the teaching-learning process in students (Rivera et al. 2020).

In accordance with what has been described, the development of an application of AR is proposed as a support to the teaching-learning process in the subject of Indus-trial Robotics in high school students, allowing a brief introduction to Robotics and its applications using immersive ICT tools (Yugcha, 2019).

APPLICATION DEVELOPMENT

This section details the creation of an AR application using Unity 3D that consists of the following stages: i) Image Target, ii) Importing the 3D Model, iii) User Interface and iv) Virtual Animation.

Image Target

To perform the recognition of the pattern that triggers the AR in the developed app, the image shown in Figure 1 was modeled, which will serve as Image Target. The design was made in Photoshop, to later be imported to Vuforia. The Unity engine detects and tracks the image by comparing the natural features extracted from the image through the camera against a known target resource database.

Figure 1. App image target

Importing the 3D Model

The 3D model is a KUKA Robot Arm. It was exported in the SolidWorks software to modify parameters that fit the needs of the app, including making the parts of the Robot separately (see Figure 2). The 3D model is saved in IGIS format to later import it into the 3DS Max program, which allows to save the design as an object with an FBX extension to use it in Unity.

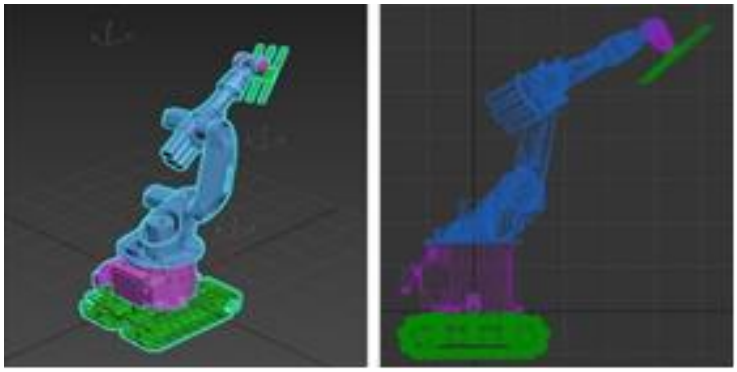

Figure 2. Importing the 3D model

User Interface

Figure 3. Main menu

The design of the app is intuitive and easy to use to improve the functionality degree and the user experience. Therefore, scenes were developed to contribute to the teaching of Industrial Robotics and its practical applications. In Figure 3, the main menu of the app is shown. The interface of the scenes from the main menu contains the different characteristics and contents based on the level of instruction for the subjects of the specialty of Mechatronics of high school; among them are concepts related to AR and VR, antecedents, definitions, and applications of robotics. The AR training scene is oriented to the teaching of characteristic, morphology of the manipulator, parts and components, as well as their classification, explosion / implosion of parts and applications of an industrial robotic arm.

Virtual Animation

To enhance the realistic experience with the 3D model; animation clips linked by the Animator Controller are used, which allows to organize and maintain a set of animation clips by associating transitions for the virtual manipulator. This property is used in the submenu components; where it will be possible to visualize the components of the robotic arm in 3D, unfolding the base, rotating column, oscillation arm, arm, wrist, actuators as an explosion and implosion of the arm. In the submenu applications will find 3D scenes of welding, suction pad, vehicle assembly and tracked undercarriage.

CLASSROOM EXPERIMENTS WITH AR

With the goal high school students work through a collaborative environment and additionally; contribute with their creativity through the management of tools with AR to improve the robotics teaching-learning process, a design and implementation of a mobile application called “Kentito” has been carried out. It takes advantage of the power of the Unity 3D and Vuforia software, which offer digital editions along with the option of being able to add objects and see them in 3D. The activities scheduled for the class sessions include: General indications of the class, installation instructions and access to the application, identify the components and subsystems of a robotic arm, perform a knowledge test on the main topics studied in augmented reality and robotics.

TEST APPLICATION

This stage shows the experimental results obtained with the use of the app in a learning process. The sample is determined by 30 students from the technical area in “Dayuma Kento” school - Ecuador, divided into two groups: a) Control group, made up of students who do not have connectivity where their learning is through pedagogical cards, consists of 18 students; b) Experimental group, made up of students who have internet connection, where learning is through the use of the application and is made up of 12 students.

A pre-test evaluation was developed for both groups before the intervention, and a post-test after the 7 learning stages ended. The evaluations made possible to assess the difference respecting to the academic performance of the control group learning with traditional techniques based on pedagogical cards and the control group that used the app developed in this proposal.

Figure 4. Result of academic performance of the control and experimental groups

According to the data presented in Figure 4, the control group obtained a difference respecting to the academic performance mean between pretest and posttest of 1.7. which represents an increase of 24%. In contrast, the difference in means with the experimental group is 4.2, representing an improvement of 42%. The results show that there is better academic learning using the proposed application based on augmented reality.

CONCLUSIONS

The implementation and use of digital ICT tools in the teaching-learning process implied an interaction through immersive environments using 3D models, motivating technological innovation in improvements in learning processes.

This digital tool will help students to achieve meaningful learning by complementing their basic digital skills in the development of their training modules related to Industrial Robotics such as: servomechanisms, micro-controlled systems, control interfaces, digital electronics, electrical engineering, and general electronics

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