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The implementation of augmented reality as a support instrument in the training of predictive maintenance

La implementación de la realidad aumentada como un instrumento de apoyo en el adiestramiento del mantenimiento predictivo

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Abstract

Augmented Reality is an emerging technology, the use of which can complement the perception and interaction with the real world and allows the student to be in a real environment augmented with additional information generated by the computer. This technology is gradually being introduced into new areas of application such as, among others, the training of industrial process operators, marketing, virtual tours, among others. The academic world is not on the fringes of these initiatives and has also begun to introduce Augmented Reality technology in some of its disciplines. However, the knowledge and applicability of this technology in teaching is minimal; Among other reasons, it is due to the very nature and state of development of said technology, as well as its scarce presence in the daily spheres of society. The development of initiatives in the use of this technology in education and its dissemination will contribute to its extension in the teaching community and especially in helping the understanding of various topics where it is sometimes not possible to have expensive materials for students of maintenance races

Augmented reality, Education, Predictive maintenance

Resumen

La Realidad Aumentada es una tecnología emergente, cuyo uso puede complementar la percepción e interacción con el mundo real y permite al estudiante estar en un entorno real aumentado con información adicional generada por la computadora. Esta tecnología está poco a poco introduciéndose en nuevas áreas de aplicación como son entre otras el entrenamiento de operarios de procesos industriales, marketing, recorridos virtuales entre otras. El mundo académico no está al margen de estas iniciativas y también ha empezado a introducir la tecnología de la Realidad Aumentada en algunas de sus disciplinas. Sin embargo, el conocimiento y la aplicabilidad de esta tecnología en la docencia es mínima; entre otros motivos se debe a la propia naturaleza y estado de desarrollo de dicha tecnología, así como también a su escasa presencia en los ámbitos cotidianos de la sociedad. El desarrollo de iniciativas en la utilización de esta tecnología en la educación y su divulgación contribuirán a su extensión en la comunidad docente y sobre todo en la ayuda de la comprensión de diversos temas donde a veces no es posible contar con materiales costosos para los alumnos de las carreras de mantenimiento.

Realidad aumentada, Educación, Mantenimiento predictivo

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Introduction

In these times, the technological and economic changes that are taking place generate uncertainty in recent graduates as they doubt their ability to get a job, as industries increasingly require an infinite number of skills in the area of maintenance, to achieve the optimal functioning of the production areas.

With this precedent, it is of great importance to link the industry with the academy before the stay, so that employers can be up to date with the scope, applications and potential of the students. Taking the above into account, this research contributes scientifically and academically with the aim of documenting and providing didactics to involve students in the subject of Industry 4.0, seeking the enrichment of new professional competences.

Likewise, it was also possible to provide tools for analysing projects for their feasibility and application in industry, as the subject of Augmented Reality had never been addressed at the Technological University of Jalisco as a support tool for maintenance, which presented an opportunity to contribute to knowledge with the learning and teaching of new professional competences, both for students and teachers.

Hence the intention to use the topic of augmented reality as a subject focused on the development of applications in the area of predictive maintenance, taking advantage of the example of some companies that already use it in their inspection processes.

Literature review

The integration of emerging technologies in industry has been one of the most recurrent lines of research in the last 10 years, and some of the contributions of the state that are related to the continuous evolution of these technologies stand out (Furth, 2011; Villalustre, 2016). In recent years, university education systems have brought about a series of alternatives and proposals for education using the Internet as a great communication tool and trying to displace face-to-face classes (Sevillano and Vázquez-Cano, 2015).

Similarly, the challenge for universities, in this framework, consists of the search for new educational alternatives around professional competences rather than around traditional subjects in such a way as to stimulate the development of didactic proposals that involve collaborative work for the promotion of valuable learning and the successive increase in the teaching activity of the use of emerging technologies that combine different approaches that are more creative and collaborative (Bressler and Bodzin, 2013; Vázquez-Cano et al., 2015; Álvarez-Marín et al., 2017).

In this sense, the educational and technological reality within the university goes hand in hand with the incorporation of new tools that bring students closer, in a simple way, to the curricular content. One of the technologies that is currently gaining momentum and importance is Augmented Reality, which has been making headway, especially in higher education (Chang, et al., 2013; Cuendet, et al., 2013; Cabero and García, 2016; Barroso and Gallego-Pérez, 2017). Nowadays, emerging technologies such as Augmented Reality (AR) are becoming more popular (Kipper and Rampolla, 2012; Moreno-Martínez and Leiva-Olivencia, 2017); this technology is estimated to have a training horizon in schools of 3 to 5 years (Johnson et al., 2013). Also, it can be observed that in the latest "EduTrend" report carried out by the Observatory of the Tecnológico de Monterrey (Tecnológico de Monterrey, 2015), it is placed as a technology with an adoption time in the centres of the Tecnológico de Monterrey of between one and two years. Augmented Reality (AR), according to Cabero and García (2016) and Barroso, et al. (2016), is a technology that allows the combination of digital information and physical information in real time through various technological supports such as, for example, tablets or smartphones, to generate a new and beneficial educational scenario.

On the other hand, Fombona et al. (2012) and Neven et al. (2011) define augmented reality as a tool that allows images of reality to be enlarged, based on their capture by the camera of a PC or smartphone that adds virtual elements for the construction of a mixed reality with computer objects.

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Cabero and García (2016), for their part, mention the most significant properties: being a mixed reality, integrated in real time, possessing a diversity of layers of digital information, which is interactive and which, through its use, enriches or alters the information. Augmented Reality therefore offers countless educational possibilities and immense potential to enhance learning and teaching (Bacca et al., 2014; Prendes, 2015). In addition, it provides students with access to rich, varied and meaningful multimedia content, providing them with a relevant context with which they can interact immediately (Cabero and García, 2016). As mentioned by Di Serio et al. (2013) augmented reality systems are distinguished by three basic properties: a) combining real and virtual objects in a real environment, b) aligning real and virtual objects with each other, and c) executing them interactively and in real time. From a technological point of view, Cabero and Barroso (2016), adding to the proposals of various authors, mention the different resources and technological devices required for the production and observation of augmented reality objects, specifically the authors point out the following: 1) An element that captures the image of the reality that the users are seeing (computer screen, a telephone, or a video console); 2) A device to project the mixture of real images with the synthesised images (the three mentioned above can be used); 3) A processing element or several processing elements that are necessary for the production and observation of augmented reality objects; 3) A processing element or several that work together whose function is to interpret the real world information received by the user, generate the virtual information that each specific service needs and mix it in an appropriate way (computers, mobile phones or video game consoles); 4) A specific type of software for the production of the programme; 5) An augmented reality activator or markers that can be QR codes, physical objects, GPS....); and 6) A content server where the virtual information that we want to incorporate into reality is located". Augmented Reality requires contextualised studies in training processes that allow us to identify its advantages and limitations; a technology whose functionality and practicality has been focused on by various researchers (Prendes, 2015; Garay et al., 2017).

Methodology

By implementing the use of Augmented Reality as a didactic resource in University education for predictive maintenance applications with 2nd term students it will serve to strengthen professional competencies, position the brand and strengthen the sense of relevance in both teachers and students at UTJ.

Hence, this research is proposed as an exploratory study whose main objective is to raise awareness of augmented reality as an option for developing competences in university education. To this end, a methodological conception based on virtual collaborative research-action by the student was taken into account as an alternative for encouraging their own generic and specific competences in the Higher Education Area (Pool-Cibrian and Martínez-Guerrero, 2013). This methodological idea is based on fostering the responsibility of team or collaborative work. The experiences provided by Millis and Rhem (2010) show that collaborative or team work is a strategy that contributes to enhancing and promoting learning by allowing different points of view and opinions to be valued, which helps to improve one's own perspective and facilitates exchange, as it stimulates and guides learning to successfully address communicative situations between peers. Quantitative approaches are not able to describe cognitive abilities in virtual learning environments. Usual statistical techniques lead to a perception of structures, which means that their results are always distributions (univariate or multivariate) of individual attributes. Therefore, we opted for a methodology with a qualitative approach that allows us to analyse in greater depth the functionality, limitations and possibilities of the didactic use of augmented reality by students who have used it in training processes.

The qualitative analysis was based on a coding and categorisation process structured in two stages: the descriptive stage and the interpretative stage. The procedure was organised in three phases: 1) Phase 1: "Segmentation and identification of units of meaning and grouping into descriptive categories". 2) Phase 2: "Construction of a system of emerging thematic nuclei" and 3) Phase 3: "Identification of qualitative domains (sequential and transversal analysis of the categories)".

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The participant sample consisted of 24 students from the Technological University of Jalisco with the following characteristics: corresponding to the second semester of the mechatronics degree in the flexible manufacturing area. The questionnaire "Didactic use of Augmented Reality as a tool for predictive maintenance" was designed (The link is: https://docs.google.com/forms/d/e/1FAIpQLSelA55_O2pPbPRFj2w8JbOs7X20S5JIiT6gwX5TMP6jW9485g/viewform).

The design of the questionnaire was based on the theoretical considerations made by Barroso and Gallego-Pérez (2017) and was reviewed by expert judgement in order to delimit the main possibilities of Augmented Reality applied in training contexts applied to predictive maintenance in Higher Education. The main objective of the questionnaire was to gather the opinion of the students according to descriptive and evaluative aspects of the different applications of Augmented Reality as a tool to facilitate predictive maintenance within University Education.

Results

The objective pursued in this research is to present a project model for the development of predictive maintenance applications using augmented reality as a strategy to develop new professional skills, and at the same time to position the brand and sense of belonging of the participants involved towards the Universidad Tecnológica de Jalisco.

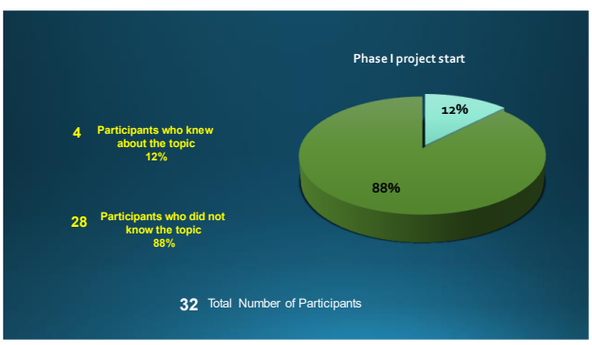

Figure 1 Start of the project
Source: Own elaboration

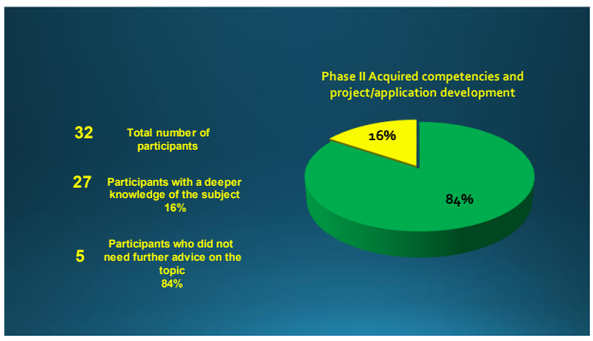

Figure 2 Phase II Competences acquired and project development / application
Source: Own elaboration

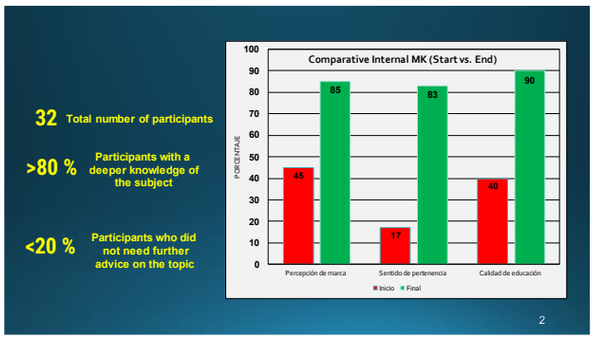

Figure 3 Comparison of start vs. end
Source: Own elaboration

Discussion

I consider that the main objective was achieved by increasing the level of acquired competences in the participants, as well as increasing the level of brand perception and brand belonging, with respect to the general population of the university.

As a result, it can be mentioned that the present research made its contributions and benefits, leaving the precedent of taking advantage of unit 3 of visualisation of the subject of electrical circuits, the development of projects with emerging technologies, applicable to these times of change such as industry 4.0.

By innovating educational programmes with emerging technologies, students increase their sense of perception, belonging and branding towards the university.

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Figure 4 UTJ AR logo developed in class
Source: Own elaboration

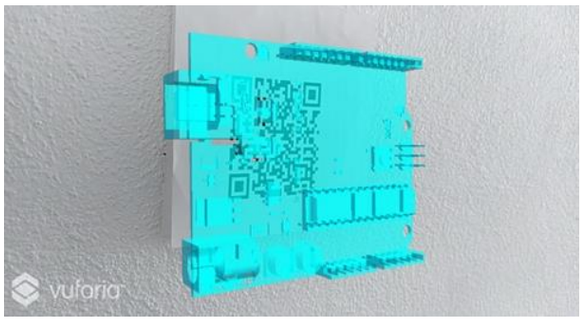

Figure 5 Arduino AR board developed in class
Source: Own elaboration by the students themselves

And as a new way of positioning the Technological University of Jalisco within the state's higher education ecosystem, using the subject of drones with a dual purpose. Development of professional skills and a sense of belonging to the UTJ.

Conclusions

Although this research contributes new content that should be considered for incorporation into teaching - such as increasing competences or motivation, it is necessary to increase studies on the incorporation of this technology in the educational field. This is due to the fact that the vast majority of the research that has been carried out focuses on less specific actions, so it is necessary to give a more specific approach to the use of augmented reality as a tool for teaching predictive maintenance. On the other hand, the results that can be seen in other research, allow us to appreciate the panorama that Augmented Reality technology can be incorporated into university teaching to facilitate the acquisition of skills by students, hence it is due to a number of aspects, among which we could highlight: the interactive and participatory context that it creates for students, as well as the levels of satisfaction; and, on the other hand, the motivation and acceptance that this technology awakens in the students.

Finally, it is necessary to emphasise that, if this technology is to be incorporated into training, it is necessary for universities to have the appropriate equipment to carry it out.

As an anecdote it is worth mentioning that one as a teacher is the guide of the students, since experience has shown that the students can produce excellent works in a self-taught way, it is only a question of motivation.

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