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REVIEW

Application of augmented reality in space exploration and astronomy

Aplicación de realidad aumentada en la exploración espacial y la astronomía

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ABSTRACT

Introduction: augmented reality (AR) integrates signals captured from the real world with signals generated by computers, making them correspond in the construction of new coherent realities, which complement and coexist in the real world and the virtual world.
Objective: characterize the impact of augmented reality on astronomy and space exploration issues.
Method: a review of the bibliography was carried out using articles rescued from databases such as SciELO, Dialnet, Scopus, Researchgate, recovering a total of 16 reference articles from available literature related to the topic in question, included in the time frame. between 2019 and 2024.
Results: AR constitutes powerful tools for teaching Astronomy, since they allow the observation of stars, constellations and the solar system, facilitating the explanation of celestial phenomena to the educator, generating behaviors of satisfaction, interest, autonomy and, above all, motivation towards The learning of topics related to the universe, maintains the real world that the user sees, complementing it with virtual information superimposed on the real one, thus favoring decision making, the formulation of predictions and solutions and even developing mathematical models.
Conclusions: augmented reality constitutes a powerful tool for the acquisition of skills and knowledge, allowing real-time visualization of astronomical data, scientific education and dissemination, space simulations, but above all it allows us to understand and discover the immensity of the universe that surrounds us.

Keywords: Augmented Reality; Space Exploration; Astronomy; Technology.

RESUMEN

Introducción: la realidad aumentada (RA) integra señales captadas del mundo real con señales generadas por computadoras, las hace corresponder en la construcción de nuevas realidades coherentes, que se complementan y coexisten en el mundo real y el mundo virtual
Objetivo: caracterizar el impacto de la realidad aumentada en temas de astronomía y exploración espacial.
Método: se realizó una revisión de la bibliografía mediante los artículos rescatados desde las bases de datos como SciELO, Dialnet, Scopus, Researchgate, recuperándose un total de 16 artículos referenciales de literatura disponible relacionados con el tema en cuestión, comprendidos en el marco de tiempo entre el 2019 y 2024.
Resultados: la RA constituye poderosas herramientas para la enseñanza de la Astronomía, ya que permiten observar las estrellas, constelaciones y sistema solar, facilitando la explicación de los fenómenos celestes al educador, genera

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comportamientos de satisfacción, interés, autonomía y sobre todo de motivación hacia el aprendizaje de temas relacionados al universo, mantiene el mundo real que ve el usuario complementándolo con información virtual superpuesto al real favoreciendo así la toma de decisiones, el planteamiento de predicciones y soluciones e incluso desarrollar modelismos matemáticos

Conclusiones: la realidad aumentada constituye una herramienta potente para la adquisición de habilidades y conocimientos permitiendo la visualización en tiempo real de datos astronómicos, la educación y divulgación científica, simulaciones espaciales, pero sobre todo permite comprender y descubrir la inmensidad del universo que nos rodea.

Palabras clave: Realidad Aumentada; Exploración Espacial; Astronomía; Tecnología.

INTRODUCTION

Augmented reality (AR) is a way to interact with physical reality in real-time. It is used to define a vision through a technological device, direct or indirect, of a physical environment of the natural world, whose elements are combined with virtual elements for the creation of mixed reality in real time. The fields of application are many; among them we can mention Manufacturing, maintenance, and repair of machinery, equipment and components, entertainment, advertising, education, and medicine.[1]

When it comes to its concreteness, the first thing is to avoid falling into the error of believing that it is recent because already in the 90s, the term was used in different fields ranging from medicine to aeronautics, robotics and tourism. However, we must recognize that it has been in recent years that it has acquired greater significance and presence, both in the industrial sector and in leisure and training.[2]

The purpose of AR is to superimpose three-dimensional images on the images provided by the camera. This technique is being used in medical applications mainly because it generates an increase in the visual signals perceived by the surgeon with an enlargement of his visual perception, which is reflected in greater precision and success in interventions; in addition, it improves the surgeon's hand-eye response thanks to the enlargement of reality. In contrast to virtual reality, which recreates a mostly artificial environment, augmented reality enriches reality, which is more acceptable to the human eye and brain.[3]

In order for AR to be reproduced, 3 fundamental components are needed: a natural object that functions as a reference for the interpretation and creation of the virtual object. The presence of a device with a camera to transmit the image of the real object. Moreover, finally, a software responsible for interpreting the signal transmitted by the camera.[4] Augmented reality (AR) is part of what has come to be known as emerging technologies. It is a technology that has been gaining strength in digital education due to the flexibility it provides in terms of facilitating learning about specific subjects in an interactive and immersive way.[5]

Interactive educational resources are part of those technological means that can promote better learning since the use of multimedia materials provides teaching options that facilitate an effective and better-quality educational process. The trends continue to grow and the new devices, increasingly accessible and ubiquitous, are joined by new technological trends and didactic strategies such as augmented reality. Astronomy is one of the oldest sciences, but given the technological growth, it is also a modern science; through AR, it is possible to enhance the skills, attitudes, and knowledge that allow them to understand, appreciate, and care for their natural environment, enhancing their curiosity and capacity for wonder.[6]

The convenience of involving in the educational scenario interactive strategies for the teaching of topics such as Astronomy, generating in students interest in the discovery of the world and the Universe that surrounds them, is exposed. In the same way, for society in general, it is possible to describe the importance of linking the teaching of Astronomy to education programs and, in this way, promote consultation on science topics besides generating spaces mediated by AR.[7]

Therefore, the objective of this review article is to characterize the impact of augmented reality on astronomy and space exploration.

METHOD

A review of the available literature was conducted using the synthetic and historical-logical analytical methods through articles retrieved from databases such as SciELO, Dialnet, Scopus, and Researchgate, retrieving a total of 16 referential articles of available literature related to the topic in question, comprised of the time frame between 2019 and 2024. Filters were used to select articles in English and Spanish. The terms "Space Exploration," "Augmented Reality," "Technology," and "Astronomy" were used as keywords in the article.

RESULTS

The human brain more widely accepts augmented reality because it retains much of the natural visual pathway, in contrast to another popular technology called virtual reality, which is characterized by creating a completely artificial environment and vision. In recent years, AR medical applications have had a rapid expansion, led by advances in hardware (interfaces, haptics, and displays), at the same time as smartphones.

Smartphones and tablets have become increasingly popular tools for AR applications in medicine, industry, and education.[8]

It is essential that augmented reality overcomes the initial stage in which it is and begins to occupy a relevant place both outside and inside the classroom, consolidated as a valuable motivational and teaching-learning tool; perhaps, someday, augmented

reality will be a relevant element in the educational world. Augmented reality has made it possible to establish a safe alternative to laboratory practices or classroom practices by including them in a more controlled environment.[9]

Álvarez-Herrero et al.[10] state that taking learning to the street, to the context and the reality closest to the students, has always been a resource with which positive results have been experienced. Doing so, accompanied by an appropriate and coherent use of digital technologies, brings more excellent benefits when we are also talking about secondary school students and the use of smartphones and social networks.

The coherent integration of this technology in real-time offers a diversity of layers of digital information and its possibility of interaction; for the construction of the content, the person must intervene and enrich or alter the information of reality with the information that is integrated. It is a technology, that of cell phones, strongly available to students, and with respect to which they show a high degree of agreement for its use as a learning technology.[2]

About this technology, Suárez Rodríguez[11] assures that Digital Elevation Models (DEM) are numerical data structures that represent the spatial distribution of elevation, providing quantitative and continuous information for the visualization of variables. On the other hand, Augmented Reality is a system that involves the user and complements the visualization of the natural world through virtual elements. The linking of Augmented Reality with Digital Elevation Models generates a significant contribution to the visualization, interaction, and understanding of phenomena. Linking DEM with AR environments has a positive impact on the ability to interpret relief and satellite images and even allows the development of mobile applications.

AR integrates signals captured from the real world with signals generated by computers, matching them in the construction of new coherent realities, which complement and coexist in the real world and the virtual world, enriching cognitive experiences in the visual order and undoubtedly improving the quality of communication in the context in which students and teachers work.[1]

Pérez-Lisboa et al.[6] evidenced in their results that progress in scientific language by recognizing elements of the Universe, semantic aspect, expressing ideas and explanations about astronomical events, and morphosyntactic aspect, which children met in the educational intervention. Augmented reality and the Stellarium program are powerful tools for teaching astronomy, as they allow observing the stars, constellations, and solar system, facilitating the explanation of celestial phenomena to the educator.

In turn, Alzate et al.[7] found that the use of AR tools focused on education generated students' behaviors of satisfaction, interest, autonomy, and, above all, motivation toward learning topics related to the Universe, the solar system, space exploration and the planet Earth. It showed that the implementation of AR fulfills a mediating function within the teaching and learning processes where the teacher uses it as an aid tool. However, at the same time, it is essential to give intentionality to the activities and content, in this case of Astronomy, so that it is within the context that is desired to apply virtual presence, having all the necessary elements so that the subject can navigate autonomously, interested and pleased to acquire the new learning.

Augmented reality does not replace the real world with a virtual one. However, on the contrary, it maintains the natural world that the user sees, complementing it with virtual information superimposed on the real one. The user never loses contact with the natural world within sight and, at the same time, can interact with the superimposed virtual information.[4]

The intention of identify the narrative possibilities of augmented reality through the creation of an interactive 3D animation on astrophysics topics. To achieve this, a series of conceptual, aesthetic, and technological elements of augmented reality were identified that allowed the creation of an immersive narrative using 3D animation, with relevant astrophysics topics such as black holes, wormholes, and general relativity, as well as its validation with thematic experts. Finally, an audiovisual translation is proposed that takes these concepts, both technical and thematic, to a virtual space using augmented reality. Currently, the literature and uses of AR that deal with scientific topics are used more to expand the information seen through the screen rather than so much in creating immersive narratives of scientific dissemination using this technology.[12]

Castro Rojas[13] conducted, in his study, a diagnosis in which he evaluated the initial state of the students regarding their knowledge of astronomical concepts and their production of narrative texts. In accordance with the didactic guidelines on the teaching of astronomy, learning workshops were adapted and designed from virtual work at home, and progress was evaluated. Their research allowed children to explore the world from different perspectives, improve the richness and practice of their narrative production, and take ownership of astronomical concepts.

It is a technology that can be adapted to different educational practices and experiences that can range from objectivist learning, since it allows students to learn specific skills and protocols of action perfectly defined and structured, to constructivist positions, where students have to adopt active positions for the construction of knowledge and from actions where information is presented through these objects in learning situations based on games or problems.[2]

At present, there are numerous space missions aimed at mapping our galaxy. One of the most outstanding is the Gaia mission, the jewel of the European Space Agency, whose main objective is to create a three-dimensional map of the Milky Way in order to investigate its composition, formation, and evolution. At the moment, the latest data available belong to Early Data Release 3. They are managed by the DPAC (Data et al.), a European consortium formed by researchers and expert scientists dedicated to the processing and analysis of the data collected by the satellite from our solar system.[14]

This work details the 3D representation and animation of the mentioned clusters, making use of the Early Data Release 3 data. This application allows the user to interact with the stars that compose each cluster, to consult information related to them, as well as to visualize their movement over time. In addition, the application integrates Augmented Reality technologies to visualize and interact with the clusters in a more intuitive way by means of the glasses.[14]

Astronomy is a science that enables interdisciplinarity, generates interest and curiosity in people of all ages, and has been a pioneer in the development of scientific thinking. Astronomy allows the consolidation of some of the concepts of the natural sciences and promotes technological advances and innovation that have contributed to the social development of civilizations. The

methodological basis of the didactic sequence allows for an immersive environment in which the children recognize the work of the astronomer and particularly of the astronaut; this implies assuming a position of closeness to the astronomical sciences, thus allowing scientific concepts to be developed in a contextual environment, in which problematic situations arise, phenomena that require explanation and particularities of scientific work such as decision making, the approach of predictions and solutions and even developing mathematical modeling.[15]

The potential use of augmented reality and design is recognized as alternative tools within educational institutions for the creation of instruments that allow the development of motor and spatial skills in preschool students, seeking to improve the academic performance of children in the school environment.[16]

CONCLUSIONS

Augmented reality is a powerful tool for the acquisition of skills and knowledge, allowing real-time visualization of astronomical data, education and scientific dissemination, and space simulations. However, above all, it allows us to understand and discover the vastness of the Universe around us.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORSHIP CONTRIBUTION

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REFERENCES

1. Vidal Ledo M, Lío Alonso B, Santiago Garrido A, Muñoz Hernández A. Realidad aumentada angel. Educ Medi Sup [Internet]. [citado 14 de enero de 2024];31(2). Disponible en: http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S0864-21412017000200025&lng=es

2. Almenara JC, Puente AP. La Realidad Aumentada: Tecnología emergente para la sociedad del aprendizaje. AULA Revista de Humanidades y Ciencias Sociales [Internet]. 2020 [citado 17 de febrero de 2024];66(2). Disponible en: https://revistas.unphu.edu.do/index.php/aula/article/view/138

3. Larrarte EMA, Alban OAV, Navarro JMS. Una aproximación a la realidad aumentada y sus aplicaciones quirúrgicas. UCP [Internet]. 2018 [citado 14 de enero de 2024];12(24). Disponible en: https://revistas.ucp.edu.co/index.php/entrecienciaeingenieria/article/view/83

4. Guataquia Quevedo O. APLICACIÓN DE LA REALIDAD AUMENTADA COMO HERRAMIENTA TECNOLÓGICA EN EL MEJORAMIENTO DEL PROCESO DE ENSEÑANZAAPRENDIZAJE DE LA GEOMETRÍA EN EL GRADO NOVENO. Univ de Sant [Internet]. 2021 [citado 17 de febrero de 2024]; Disponible en: https://repositorio.udes.edu.co/server/api/core/bitstreams/64ae1ee7-7e66-42b8-bbc3-cdeacedb9519/content

5. Márquez Díaz, JE, Morales Espinosa, LA. Realidad aumentada como herramienta de apoyo al aprendizaje de las funciones algebraicas y trascendentes | Revista Educación en Ingeniería. Rev Educ Inge [Internet]. 2020 [citado 13 de enero de 2024];15(29). Disponible en: https://educacioneningenieria.org/index.php/edi/article/view/1037

6. Pérez-Lisboa S, Ríos-Binimelis CG, Castillo Allaria J, Pérez-Lisboa S, Ríos-Binimelis CG, Castillo Allaria J. Realidad Aumentada y simuladores: astronomía para niños y niñas de cinco años. ALTERIDADRevista de Educación [Internet]. junio de 2020 [citado 17 de febrero de 2024];15(1). Disponible en: http://scielo.senescyt.gob.ec/scielo.php?script=sci_abstract&pid=S1390-86422020000100025&lng=es&nrm=iso&tlng=es

7. Alzate LA, Erazo JHC, Hernández LA. Implementación de un ambiente de aprendizaje mediado por el recurso NASA Space Place para motivar el aprendizaje de la Astronomía desde las Ciencias Naturales en los niños del grado cuarto de las instituciones educativas San Cayetano I.E.D. de la ciudad d: Implementation of a learning environment mediated by the NASA Space Place resource to motivate the learning of Astronomy from Natural Sciences in fourth grade children of the San Cayetano I.E.D. educational institutions in the city of Bogota and Agroindustrial Victor Manuel Chaux Villamil, in the department of Cauca. LATAM Revista Latinoamericana de Ciencias Sociales y Humanidades [Internet]. 24 de febrero de 2023 [citado 17 de febrero de 2024];4(1). Disponible en: http://latam.redilat.org/index.php/lt/article/view/402

8. Aguilar Larrarte EM, Vivas Albán OA, Sabater Navarro JM. REALIDAD AUMENTADA CON MARCADORES CUADRADOS Y NATURALES PARA NAVEGACIÓN QUIRÚRGICA. Pistas Educativas [Internet]. 28 de febrero de 2018 [citado 14 de enero de 2024];39(128). Disponible en: https://pistaseducativas.celaya.tecnm.mx/index.php/pistas/article/view/1166

9. Sáenz del Amo R. Diseño y desarrollo de material didáctico en realidad aumentada: vídeo de presentación. Univ de Burg [Internet]. 2020 [citado 18 de febrero de 2024]; Disponible en: https://riubu.ubu.es/handle/10259/5350

10. Álvarez-Herrero JF, Hernández-Ortega J. Itinerarios didácticos con smartphones para promover la educación ambiental y la competencia digital entre el alumnado de secundaria | Digital Education Review [Internet]. 2021 [citado 12 de enero de 2024]. Disponible en: https://revistes.ub.edu/index.php/der/article/view/32957

11. Suárez Rodríguez JM. GeoAR, integración de modelos digitales de elevación en ambientes de realidad aumentada. Udistrital [Internet]. 15 de diciembre de 2021 [citado 18 de febrero de 2024]; Disponible en: http://repository.udistrital.edu.co/handle/11349/30565

12. Ealo Otero LC. Univerzoom : una propuesta narrativa en realidad aumentada para la divulgación de la ciencia en temas de astrofísica. Univ de Antio [Internet]. 2022 [citado 17 de febrero de 2024]; Disponible en: https://bibliotecadigital.udea.edu.co/handle/10495/29762

13. Castro Rojas YA. Narraciones infantiles a partir del aprendizaje de conceptos astronómicos. UPTC [Internet]. 2020 [citado 17 de febrero de 2024]; Disponible en: https://repositorio.uptc.edu.co//handle/001/8918

14. Lodeiro Vázquez A. Representación, visualización y animación 3D de cúmulos estelares mediante realidad aumentada. RUC [Internet]. 2022 [citado 18 de febrero de 2024]; Disponible en: https://ruc.udc.es/dspace/handle/2183/31887

15. Navarrete Flórez DS, Valderrama DA. Apropiación conceptual de la astronomía en el contexto de la educación primaria. UPTC [Internet]. 2020 [citado 18 de febrero de 2024]; Disponible en: https://repositorio.uptc.edu.co//handle/001/3190

16. Osorio C, Luisa M. La realidad aumentada como tecnología potenciadora del desarrollo de la percepción espacial en niños de 5 a 6 años de edad de grado preescolar. Univ de Caldas [Internet]. 21 de septiembre de 2022 [citado 18 de febrero de 2024]; Disponible en: https://repositorio.ucaldas.edu.co/handle/ucaldas/18084