Virtual Reality in Astronomical Education: Improving the Understanding of Eclipses with Interactive Simulations.

Ana Cesarina de Oliveira Carneiro
Gabriel Antoine Louis Paillard
anaoliveirna@alu.ufc.br
gabriel@virtual.ufc.br
Department of Computing
Federal University of Ceará
Quixadá, Brazil

João Batista de Araújo Neto*
Creto Augusto Vidal
Joaquim Bento Cavalcante Neto
joao_araujo@atlantico.com.br
joaonetoaraujo@alu.ufc.br
cvidal@dc.ufc.br
joaquimb@dc.ufc.br
Department of Computing
Federal University of Ceará
Instituto Atlântico
Fortaleza, Ceará, Brazil

Antonio José Melo Leite Junior
George Allan Menezes Gomes
melojr@virtual.ufc.br
george@virtual.ufc.br
Virtual UFC Institute
Fortaleza, Brazil

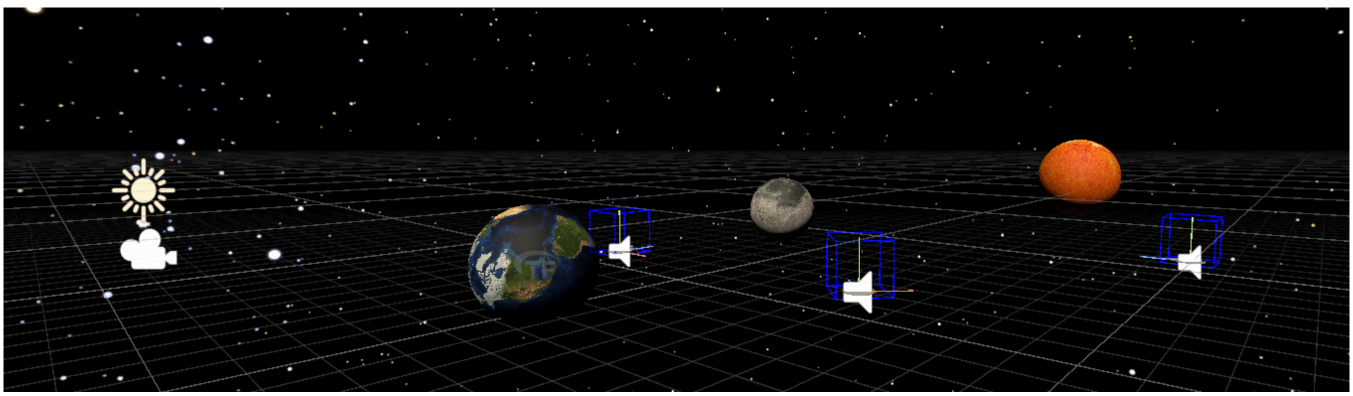

Figure 1: Final Execution Virtual Space Scheme.

Abstract

The teaching of astronomical concepts, such as eclipses, faces challenges due to their complexity and the difficulty of spatial visualization. This research proposes the use of Virtual Reality (VR) to enhance the understanding of these phenomena. An immersive virtual environment was developed, allowing users to explore accurate simulations of solar eclipses. The approach involves the customization of celestial models, integration into a VR editor (Universal)[4], and execution of the simulations on HMDs (Universal Runner)[5]. The paper also discusses future advancements, such as the inclusion of new scenarios and the automation of experiences, aiming to improve interactive learning.

Keywords

Virtual Reality (VR), Solar Eclipses, Simulation, Celestial Models.

1 Introduction

Astronomy has been fundamental to the advancement of human knowledge, with solar eclipses standing out as fascinating and historically significant phenomena. Despite being widely studied, eclipses continue to pose challenges due to the complexity of celestial movements and the need to visualize the three-dimensional alignment of the involved bodies. Virtual Reality (VR) emerges as an innovative tool, allowing immersive and interactive visualization of these events.

As Andrew Johnson [6] emphasizes VR has the potential to transform the way we interact with complex phenomena by creating deeply engaging environments. Similarly, Merchant et al. (2014) [7] indicate that VR enhances the understanding of astronomical phenomena by enabling the simulation of events that would otherwise be impossible to observe directly.

This study proposes the use of a VR simulation, developed on a VR experience-building platform (Universal), to explore solar eclipses. The simulation allows users to visualize and interact with celestial bodies in real time, experiencing the alignment and phases of an eclipse in an immersive way. With this approach, it is possible to overcome the limitations of traditional observations, providing a more detailed and engaging experience of the astronomical phenomenon.

2 Materials and Methods

2.1 Implementation of Activities

The development of the solar eclipse simulation began with a clear and objective definition of scientific and educational purposes. The central goal was to provide an in-depth understanding of solar eclipses, a highly relevant astronomical phenomenon. To achieve this goal, it was essential to identify and define precisely the key elements that would ensure an accurate representation of the phenomenon. These elements included the detailed recreation of the celestial bodies involved in the eclipse, such as the Sun, the Moon, and the Earth.

2.2 Asset Generation

The first asset was an astronomical map, which served as the basis for the spatial positioning of celestial bodies within the virtual environment, ensuring that the relative positions of the Sun, the Moon, and the Earth were in accordance with the precise coordinates needed to simulate the eclipse.

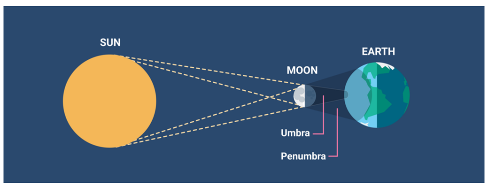

Figure 2: Lunar Eclipse Scheme from timeanddate.com

Next, the *skydome* was developed, which plays a crucial role in simulating the celestial dome. This element is responsible for creating a continuous and immersive background. Notably, an asset that accurately represents the stellar surroundings was selected, obtained through the *Unity Asset Store* [3].

For the celestial bodies, three-dimensional models of the Sun, the Moon, and the Earth were initially obtained from free repositories available in the 3D modeling community [1]. These models underwent an adaptation process in Blender [2], where realistic textures were applied to enhance the objects' authenticity.

2.3 Editor usage

With the *assets* prepared, the next step was their integration into the simulation environment using the *Universal* VR editor. This editor was chosen for its capability to handle complex simulations and allow detailed manipulation of three-dimensional objects.

During this phase, scale, and rotation adjustments were made to ensure that the proportions of the celestial bodies were accurately represented. The editor was set up with a *top-down* view, which facilitated control over the scene's layout, allowing precise supervision of the position and scale of the celestial bodies relative to each other. This level of detail was essential to ensure that the alignment of the celestial bodies accurately reproduced the astronomical phenomenon.

After configuring the *assets*, the entire scene was exported in JSON file format. This format was chosen for being a widely accepted universal standard that allows easy transfer and integration of data between different VR development platforms. The use of JSON ensured that all details of the scene were preserved, enabling its replication and modification in other simulations or applications.

The work needs to be validated to ensure that the Universal editor meets the essential requirements for creating simulations.

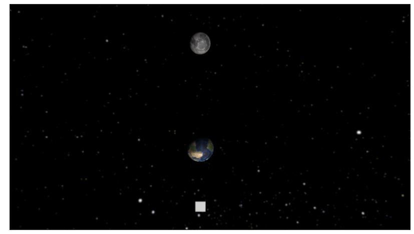

Figure 3: Top Down View of Experience making using Universal Virtual Reality Editor by the authors.

The validation involves a rigorous assessment of the editor's ability to integrate and manipulate resources effectively, generate realistic simulations, and achieve the established objectives. Validation will ensure that the editor is a reliable and effective tool, ready to be used in future applications and developments in the field of Virtual Reality.

2.4 Execution on the HMD

The final phase prepared the execution of the simulation on the Oculus Quest 2, an HMD with high resolution and a fast refresh rate. The scene created in the Universal Editor was imported to the HMD using the Universal Runner. Although it has not yet been tested by users, the simulation aims to enable exploration of the alignment of celestial bodies and observation of the solar eclipse.

In using the HMD, the application was designed to allow the user to move freely through the simulated universe. Using the Oculus Quest 2, the user will be able to explore the virtual scene and observe the celestial bodies and the astronomical phenomenon from different perspectives.

3 Conclusion

In conclusion, the study presented an innovative approach to simulating solar eclipses in a virtual environment using Virtual Reality. Although it has not yet been tested by users, the simulation shows great potential for enhancing the visualization and understanding of eclipses [4]. Future developments will include formal testing to validate the effectiveness of the tool, the creation of a lunar eclipse scenario, and the automation of the experience, with the aim of expanding its applications in different contexts.

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