Development of a web application simulation based on an astronomical observatory model with a diegetic interface.

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Content

Abstract: *This project aims to develop a web application that simulates celestial mechanics through an interactive 3D model of the solar system. The application serves as an educational tool, allowing users to visualize and explore astronomical phenomena while fostering an understanding of fundamental programming concepts. By integrating a diegetic interface, users can experience the solar system from the perspective of a spaceship, interacting with various planets and accessing a database of celestial information. This initiative addresses the need for accessible educational resources in Latin America, promoting interest in astronomy and programming among students. The application employs modern web technologies, including HTML, JavaScript (Three.js), and Firebase, ensuring a responsive and engaging user experience. The development process embraced Agile methodologies, fostering collaboration among team members and enhancing problem-solving skills. The project contributes to making complex astronomical concepts more approachable and highlights the significance of interdisciplinary learning in the fields of science and technology.*

Title

Launch Platform: A Journey Through the Mechanics of the Solar System.

Brief Description

The central objective is to propose a web application that combines the concepts of celestial mechanics with the fundamentals of programming. This will allow users to experience a visual approach in a three-dimensional space to a model that can be challenging to understand through classical mechanical models.

The development of an interactive digital model facilitates an effective dialogue with a universe increasingly engaged with new technologies. This proposal seeks new ways to interact with astronomical calculations and the physical laws governing the universe. Thus, the proposal establishes a graphical model aimed at providing users with an immersive experience in an unexplored universe.

Problem to Solve

How can a three-dimensional solar system be represented in a web application that allows users to familiarize themselves with the mechanics of the main celestial bodies through a diegetic interface?

The general problem focuses on the three-dimensional representation of the solar system, which poses significant challenges for the observer. It involves calculating movements and behaviors while varying the scale and providing descriptions of the most relevant aspects.

Why is it Important to Solve this Problem?

In a digital environment where engaging with new generations is increasingly relevant, it is essential to provide interactive access to astronomical studies in classrooms. This challenge aims to foster dialogue across different generations and extend the study of astronomy to locations where access to infrastructure is limited.

In Latin America, there are still places and institutions lacking mechanical models or sufficient resources to establish infrastructure for exploring these topics. The web platform will enable the study of the solar system from a widely accessible interface on devices that are becoming increasingly prevalent in various regions. Furthermore, this proposal envisions its service to education and promotion within classrooms.

Proposed Solution

The interface features a simulation of the solar system viewed through the eyes of a spacecraft, providing the user with a vast immersive experience. This interaction will allow users to embark on their journey into the world of astronomy. Within this environment, they will encounter challenges to solve and information about the planets along their path. Additionally, it provides access to databases containing some of the most interesting and intriguing calculations related to celestial mechanics.

Solar System Simulation: A realistic representation of the solar system.

Planetary Movements: Simulation of planets rotating on their axes and orbiting in elliptical paths.

Interaction with the Space Shuttle "Discovery": Users can navigate through the system using this shuttle.

Database for Celestial Bodies: A searchable database providing information on various celestial entities.

Information Labels: Tags containing available information for each planet.

3D Web Application: An interactive platform allowing users to explore different scenarios within the solar system.

Technologies Used

HTML: Chosen for its compatibility with browsers, ensuring accessibility to a wider audience. Additionally, its integration with other technologies like CSS and JavaScript enhances the appearance and interactivity of the web application.

JS (JavaScript) Library: THREE.js

THREE.js was chosen for its ability to simplify the creation and manipulation of three-dimensional objects. It offers high graphical performance, which is crucial for a project that involves rendering complex scenes. Additionally, it boasts extensive compatibility with modern browsers.

Database and Hosting: Firebase

Firebase was chosen for its real-time database capabilities. Given that the application requires instant updates, it serves as an excellent resource for maintaining dynamic data interactions.

GitHub Repository

GitHub was chosen because it enables multiple developers to work on the same project simultaneously. It provides cloud storage and also offers version control for tracking changes made to the code over time.

Development Process

Description of how the project was developed step by step.

The preparation phase involved studying and engaging with the various topics and resources provided by the event's website. In this phase, each participant proposed a vision for the project from their area, and the problem to be addressed was collectively established.

The second phase, following an extreme programming methodology, involved programmers continuously adapting to the various requirements and challenges that arose, both in terms of resolving formulas and in the graphical aspects. This phase concluded once the different codes were integrated and various checks were conducted.

The third phase concluded the project with a direct focus on the aesthetic elements of the interface. The database and hosting were continuously tested to ensure functionality and visual impact

Teamwork

Once the work team was assembled, meetings were held to define the work plan. In these meetings, the study of various topics was encouraged, along with joint decision-making regarding the key resources and features to be considered.

In parallel, individual consultations were held where the leader supervised and guided team members in the various tasks assigned according to their roles and profiles. Week after week, the continuation of these tasks was requested to achieve the objective.Desafíos principales:

The main topic and the complexity involved in solving the various calculations and formulas required all team members to familiarize themselves with celestial mechanics, as well as the position of the observer. This challenge allowed the team to delve into astronomy and seek to broaden their horizons, going beyond merely applying the formulas or including them in code.

The use of the THREE.js library presented a technical challenge related to three-dimensional modeling, particularly concerning graphic performance. However, as its functionality was mastered, the work led to an even greater understanding of coordinate systems and movements.

Communication through digital means was challenging for collaborative work. Although some participants were present, meetings and consultations were conducted online, which could be demanding. Despite the distance and various setbacks due to schedules and availability, agreements were reached that established the group's working hours and pace.

Project Architecture

Use Cases and Features

Description of Main Features and Functionalities of the Project:

1. Simulation of celestial orbits and their movement, enabling users to visualize the motion of planets and adjust various parameters.

2. Movements based on real physical models utilizing formulas from celestial mechanics and solving calculations such as those from Kepler and Newton.

3. Observer position centered in a spacecraft to view the scene from various three-dimensional angles within the system, offering different perspectives.

4. Interactive interface that allows users to control key elements of the system and details such as a database and labels for the different planets.

Case:

Physics Teacher

The user is interested in demonstrating to their students the properties of elliptical orbits and their relationship with the movement of planets according to Kepler's laws.

The user accesses the web application and establishes the desired viewpoint that allows them to observe the movement of the planets. They change their position with the spacecraft to study the ellipses from different angles.

In the simulation, the teacher can accelerate the motion to observe the fulfillment of Kepler's second law by watching the variation in velocity in the planets' orbits or pause the movement to examine key points, such as when a planet reaches perihelion or aphelion.

At the end, the teacher exports the screenshots of the journey taken with the students and uses the database to establish the relationship between the mechanics of the solar system and ellipses. Meanwhile, the students can recreate this simulation whenever they want and explore new points of interest or phenomena on their own.

Project Demonstration

Link for live demonstration: https://hexacoders-18f6d.web.app

GitHub repository: https://github.com/CodeArtNexus/nasachallenge

Impact and Future

•What impact do you expect your project to have on the problem you are addressing?

The project aims to facilitate the understanding of complex concepts. It seeks to address the calculations and behaviors of astronomical phenomena that are not possible to observe in other ways or that would be impossible to grasp in certain educational environments using traditional tools.

Additionally, it aims to enhance accessibility to astronomy by being a web application available on common and accessible devices, thus providing a valuable educational resource for a wide population segment.

Furthermore, it seeks to spark interest in fields such as astronomy, physics, and programming, allowing students to observe the intersection of the exact sciences and computing.

Finally, it establishes a creative approach to teaching practices where pedagogy adapts to the transmission of knowledge through a visual, practical, and participatory method that fosters learning environments in places where resources are limited.

What improvements or additional features would you add if you had more time?

A collision simulator that allows observation of the interaction between gravities.

Objects and moons with orbits so that the system includes more bodies and can access even more key points.

An interactive video game within each planet simulating specific properties of each, such as gravity and surface.

Improving the functionality of the spacecraft to enhance immersion and include new features like position and trajectory to create a more visual control interface.

Conclusions and Learnings

Throughout the project workdays, the initiative allowed the various involved areas to collaborate effectively, enabling participants to tackle challenges in new domains. These challenges, in turn, led to an exploration of astronomy focused on the resolution of formulas and calculations, as well as the various reference points for the observer.

The management of libraries and documentation played a key role in navigating the learning curve associated with them. The appropriation of various concepts and the handling of 3D modeling prompted the study of different perspectives on the reference point that would be taken into account.

Reflections on the Development Process

The development was a key aspect, and teamwork was essential. The organization proposed by the leader, along with various methodologies and stages, allowed for the utilization of each member's distinct capabilities.

Although the time was short, communication was crucial for the project to follow an appropriate course. Joint strategies, such as meetings and consultations, enabled continuous work on the project while allowing for deeper exploration of the proposal's subject matter.

Aspects That Could Be Improved in the Future

Planning and the use of more tools would help improve the quality of the project. While the planning and adherence to each stage were productive, they proved limiting when it came to exploring all the ideas for implementation in depth.

It could be beneficial to focus on reducing computational costs, thereby enhancing the simulation. Refining algorithms and optimizing the use of the graphical library could meet the objectives of balancing user experience with astronomical calculations.

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