CELESTIAL AR

(AN IMMERSIVE AR OF THE COSMOS)

A MINI-PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

Certified that this project report **" CELESTIAL AR (AN IMMERSIVE AR OF THE COSMOS)"** is the bonafide work of **"RAHUL S (221701044)**, **RITHIKA H (221701047)"** who carried out the project work for the subject CD19651 – Mini Project under my supervision.

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ABSTRACT

The Celestial AR application is designed to provide an immersive and interactive experience for users interested in exploring celestial objects through Augmented Reality (AR). This project aims to enhance astronomical education by enabling real-time visualization of planets, stars, and constellations. Utilizing a user-centered design approach, we conducted a detailed study of existing astronomy applications, identifying their strengths and limitations. The focus was on creating a seamless user interface, ensuring real-time tracking accuracy, and integrating interactive educational features. The application incorporates Unity, AR Foundation, and Google ARCore to deliver realistic celestial experiences. This report discusses the methodologies used in the development process, the implementation of AR technologies, and the impact of these features on user engagement and learning outcomes. Our study contributes to the field of Human-Computer Interaction (HCI) by demonstrating how AR-based applications can significantly improve learning experiences in astronomy education.

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CHAPTER 1

INTRODUCTION

The Celestial AR project is designed to revolutionize the way users explore and interact with celestial bodies through augmented reality (AR). As an innovative Android application, Celestial AR aims to provide an immersive and educational experience by enabling users to visualize planets, stars, constellations, and other astronomical phenomena in real-time. Traditional astronomy applications often rely on static images and complex data, making it difficult for users to grasp spatial relationships and celestial movements. Our project addresses these challenges by integrating interactive 3D models, real-time positioning, and intuitive navigation, enhancing both learning and engagement. The primary objective of this project was to develop a user-friendly AR-based application that simplifies astronomical exploration while maintaining scientific accuracy. Through extensive research, user feedback, and iterative development, the project focused on optimizing UI/UX, improving performance, and ensuring seamless interaction with AR elements. This paper outlines the development process of Celestial AR, detailing the methodologies used for data collection, user testing, and the implementation of advanced AR techniques to deliver a captivating experience.

CHAPTER 2

LITERATURE REVIEW

1. Nasa’s Eyes-Published: 2019

NASA’s Eyes is a highly informative application that provides users with 3D visualizations of celestial bodies and space missions. The app integrates real-time satellite tracking and actual space data from NASA, making it a valuable educational tool for understanding planetary movements and space exploration. Despite its accuracy and vast database, it lacks AR-based interaction, meaning users cannot visualize celestial objects in their real-world surroundings. This limitation reduces user engagement, as it lacks an interactive component that could make learning more immersive. Additionally, NASA’s Eyes does not support geolocation-based tracking, restricting users from experiencing personalized astronomical views based on their specific locations. While it provides a vast amount of space-related data, it lacks the adaptability of mobile-based AR applications.

2. Skyview-Published: 2020

SkyView is a widely used astronomy visualization application that enhances celestial tracking through geolocation-based AR. Unlike NASA’s Eyes, SkyView allows users to point their devices at the sky and identify stars, planets, and constellations in real time. One of its strongest features is its AR functionality, which makes it an accessible tool for amateur astronomers and students. Users can simply aim their smartphones at the night sky, and the app

overlays celestial information onto their camera view. However, despite its AR capabilities, SkyView does not offer 3D immersive experiences or real-time space mission simulations. While it excels at sky mapping and basic celestial identification, it lacks depth in terms of educational storytelling and interactive space learning

3. Celestial Ar-Published: 2025

Celestial AR is designed to bridge the gap between real-time space tracking, interactive AR learning, and immersive 3D experiences. Unlike NASA’s Eyes and SkyView, Celestial AR enables users to interact with celestial bodies in their real-world environment through AR-based visualization. The application allows users to track planetary movements and view constellations in real-time using AR, enhancing user engagement by making astronomy more interactive compared to traditional 2D applications. Additionally, Celestial AR offers guided storytelling and educational modules, which are absent in both NASA’s Eyes and SkyView. These features provide a more engaging learning experience, making space education more accessible and interactive. By combining AR, real-time tracking, and interactive simulations, Celestial AR offers an all-in-one space learning platform, making it a unique educational tool.

CHAPTER 3

SOFTWARE USED – MAYA & UNITY

In the initial phase of the Celestial AR project, our team conducted a comprehensive evaluation of various 3D modeling and game development tools to select the most effective software for our needs. Maya emerged as the optimal choice for 3D modeling and animation due to its industry-standard capabilities in creating high-quality assets. For development and deployment, Unity was chosen because of its powerful AR support, cross-platform compatibility, and real-time rendering capabilities. The seamless integration between Maya and Unity ensured an efficient workflow, allowing us to bring our 3D models into the AR environment with minimal effort.

3.1 Tool Selection

1. Design Implementation With Maya & Unity

Utilizing Maya, our team developed detailed and optimized 3D models of celestial objects, ensuring they were both visually appealing and performance-efficient for real-time applications. Maya's advanced modeling tools allowed us to create realistic planetary surfaces and space elements while maintaining a low polygon count for optimal AR performance. Once the assets were finalized, we integrated them into Unity, leveraging its AR Foundation framework to bring interactive celestial objects into augmented reality. Unity's real-time rendering and lighting features played a crucial role in achieving a visually immersive experience.

2. Prototyping and Feedback

An integral part of our development process involved prototyping and iterative testing within Unity. We created interactive AR simulations that allowed users to explore celestial bodies in real time. Through Unity's built-in features like timeline animations and event-driven interactions, we ensured a seamless and intuitive user experience. Usability testing sessions helped refine interactions, adjust object placements, and enhance performance. Feedback from testers provided valuable insights that guided improvements, ensuring that the final application was both educational and engaging.

3. Collaboration and Facility

Maya and Unity facilitated efficient collaboration among our team members. Maya's structured asset organization streamlined the handoff process between modelers and developers, reducing rework and ensuring consistency. Unity's version control and cloud-based project sharing capabilities allowed our team to work on different aspects of the AR experience simultaneously. This real-time collaboration reduced development time and helped maintain a unified vision for the project.

4. Realtime-Rendering

A key feature of our Celestial AR project was the utilization of real-time rendering and interaction capabilities within Unity. By leveraging Unity's real-time global illumination and shader systems, we achieved dynamic lighting and realistic environmental effects. The ability to interact with celestial objects in real time enhanced user engagement and provided an immersive learning experience. Real-time physics simulations also allowed for accurate planetary motion and orbital mechanics, making the application not only visually stunning but also scientifically informative.

5.Outcome and Impact

The adoption of Maya and Unity significantly impacted the success of the Celestial AR project. The final application provided an immersive and interactive way for users to explore celestial objects, enhancing both educational value and user engagement. Post-deployment feedback indicated high levels of interest and satisfaction, validating the effectiveness of our development approach. The project not only met but exceeded our initial objectives, establishing a scalable and interactive AR framework that can be expanded with additional features in the future.

Fig 1: The user interface of the "UNITY" software.

CHAPTER 4

PRESENT TECHNOLOGY

The current state of technology in the Celestial AR project encompasses several key components essential for delivering a seamless and immersive augmented reality experience. This section provides an overview of the existing technologies employed in the project, focusing on software architecture, real-time rendering, user interaction, and performance optimization.

4.1 Software Architecture

The Celestial AR application is built on a structured architecture that efficiently handles 3D assets, AR interactions, and real-time rendering. This architecture includes:

1. 3D Modeling and Animation: Maya is utilized to create high-quality celestial objects and animations. The tool provides detailed control over textures, lighting, and polygon counts, ensuring optimized assets for AR environments.
2. Game Engine and AR Integration: Unity serves as the development platform, leveraging AR Foundation to enable cross-platform AR experiences. It provides built-in support for real-time rendering, physics-based interactions, and seamless deployment on mobile devices.
3. Database and Cloud Support: Cloud storage solutions are integrated for handling large-scale 3D assets and ensuring real-time updates, allowing users to experience the latest content without additional downloads.

Real-Time Rendering and Interaction

A key feature of the Celestial AR project is real-time rendering, which allows users to experience dynamic lighting, realistic planetary textures, and physics-based interactions. Unity’s real-time global illumination and PBR (Physically Based Rendering) shaders contribute to an immersive and visually stunning AR experience. Additionally, interactive elements such as touch-based scaling, rotation, and information overlays provide users with an engaging and educational experience.

UI

The UI of the Celestial AR application is designed to be intuitive and accessible for all users. Key features include:

1. Responsive Design**:** The application adapts to different screen sizes and orientations, ensuring usability on various devices.
2. User-Friendly Navigation**:** Simplified menu structures and guided interactions help users explore celestial objects effortlessly.
3. Accessibility Features: Basic accessibility support is integrated, with potential improvements planned to enhance the experience for users with disabilities

4.2 Limitations of the Current Celestial AR Technology

While the Celestial AR application is built on advanced technologies, there are several limitations that impact performance, usability, and future scalability. Identifying these challenges is essential for guiding future improvements.

1. **Performance and Optimization**

   High-quality 3D models require significant processing power, which can impact performance on lower-end mobile devices.Real-time rendering and physics simulations consume computational resources, requiring further optimization for smoother experiences, Efficient level-of-detail (LOD) techniques and asset compression are essential to maintaining

2. User Interaction Challenges

Some users may find it difficult to interact with AR objects due to limited touchscreen sensitivity or tracking inconsistencies.Enhancing gesture-based controls and refining interaction mechanics could improve the overall usability of the application.

3. Accessibility and Integration

The application currently has limited support for voice commands and screen readers, making it less accessible for users with disabilities.Integration with external educational platforms and additional AR datasets could enhance the learning experience and provide more personalized content.

4. FutureEnhancements

Addressing these limitations through advanced optimization techniques, AI-powered interactions, and user-centered design improvements will enhance the effectiveness of the Celestial AR application. Future updates will focus on refining performance, expanding accessibility, and integrating new features to provide a richer and more engaging experience.

4.3 ADVANTAGES

Advantages of Developing the Celestial AR App from Scratch

Building the Celestial AR app from the ground up provides numerous benefits, ensuring a seamless user experience, future scalability, and a competitive position in the augmented reality (AR) and education market. Here are the key advantages

1. Tailored User Experience (UX)

Intuitive Design: Designing the app with a clean, user-friendly interface from the beginning ensures that users can easily explore celestial objects, interact with AR features, and engage with educational content without confusion.Immersive Interaction**:** Incorporating advanced AR elements to provide a lifelike and immersive exploration of planets, stars, and constellations enhances the overall learning experience.Personalized Learning: By integrating adaptive learning modules and AI-driven recommendations, the app can offer personalized astronomy lessons and celestial event notifications, keeping users engaged and informed.

2. Seamless Integration and Scalability

Smooth Integration with New Technologies**:** Starting fresh allows for seamless incorporation of AI, real-time data, and cloud-based storage, ensuring that the app remains compatible with future innovations.Scalable Infrastructure: Building a scalable backend ensures that the app can handle increased user traffic, especially during high-demand events like meteor showers, eclipses, or planetary alignments, without compromising performance.

3. Competitive Edge and Market Differentiation

Innovative Features: Developing the app from scratch allows for the inclusion of cutting-edge AR technologies, gamified learning experiences, and interactive simulations that set the app apart from competitors.Positioning as a Leader: By offering a unique blend of astronomy education, real-time AR experiences, and gamification, Celestial AR can establish itself as a leader in the growing space education and augmented reality sectors.

4. Future-Ready Architecture

Adaptability to Evolving Tech: Building a modular and flexible architecture from the ground up ensures that the app can adapt to future advancements in AR, AI, and spatial computing.Room for Expansion: Developing the app from scratch leaves room for future enhancements, such as multiplayer AR experiences, telescope integrations, and advanced space simulations.

CHAPTER 5

OUTPUT

PROJECT LINK

Fig 2: The Starting Interface of Celestial AR

The opening screen introduces the Celestial AR experience with an engaging animation of celestial bodies, a logo, and a “Start” button to begin the journey.

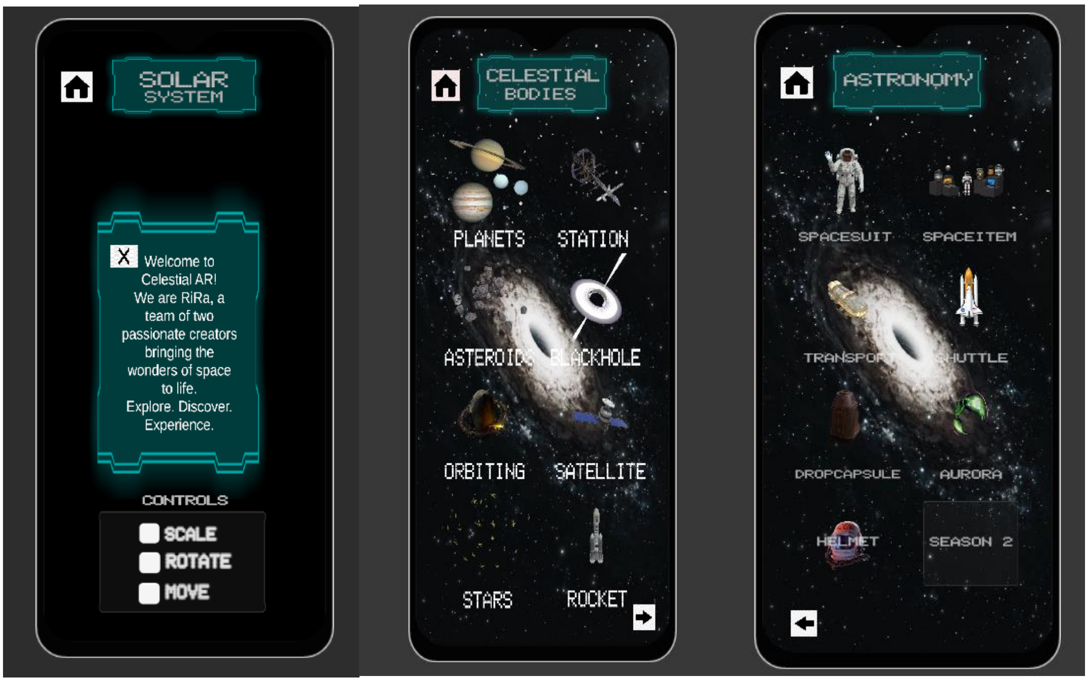

Fig 3: The Explore Page of the Celestial AR

App offers AR-based celestial exploration, space event updates, and an interactive star map. The Interactive Start Page provides guided space tours, gamified learning paths, and quick access to popular features for an immersive experience.

Fig4:The Model Output and Visualization Page of the Celestial AR Application.

Fig 5: The Settings and About Us Page of the Celestial AR Application.

CHAPTER 6

CONCLUSION

The Celestial AR app serves as a crucial platform for exploring the wonders of the universe through augmented reality, offering users an immersive educational experience about celestial bodies and astronomical events. However, as user expectations evolve and technology advances, the app requires a robust foundation to support enhanced features and seamless performance.

The development of the Celestial AR app from scratch includes a wide range of innovations, from creating an intuitive and visually appealing interface to integrating real-time data and advanced AR simulations. These enhancements aim to deliver a more immersive, educational, and interactive experience, making space exploration more accessible and engaging for users of all ages.

Furthermore, building the app with a future-ready architecture ensures that Celestial AR remains competitive in a rapidly growing market driven by technological advancements and rising user standards. As digital education and interactive learning platforms gain prominence, the ability of Celestial AR to provide a seamless, engaging, and informative experience becomes essential. This not only fosters greater user engagement and retention but also positions the app as a leader in the field of space education and augmented reality.

In conclusion, the creation of the Celestial AR app represents a forward-thinking initiative that addresses current gaps while paving the way for future enhancements. By committing to this innovative platform, Celestial AR will continue to inspire curiosity and knowledge about the cosmos, making space exploration more interactive .

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