Software Requirements Specification (SRS) Document

1. Introduction

1.1 Purpose

This Software Requirements Specification (SRS) document outlines the requirements for a web-based spacecraft simulator designed to imitate the approach to, landing on, and mining of the asteroid Psyche. The simulator aims to facilitate mission planning for scientists and engineers while providing educational resources for a broader audience.

1.2 Scope

The simulator will allow users to visualize spacecraft dynamics, landing strategies, and mining operations on Psyche. It will cater to various user groups, including NASA personnel and the general public, to enhance understanding and support future mission planning.

1.3 Definitions, Acronyms, and Abbreviations

- **SRS:** Software Requirements Specification
- **NASA:** National Aeronautics and Space Administration
- **UI:** User Interface
- **API:** Application Programming Interface

1.4 References

- NASA's Psyche mission documentation
- Academic papers on asteroid mining and spacecraft dynamics
- Web Content Accessibility Guidelines (WCAG) for usability standards

1.5 Overview

The remaining sections of this document detail the overall product description, specific requirements (functional and non-functional), use cases, and other necessary details to guide the development and implementation of the spacecraft simulator.

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2. Overall Description

2.1 Product Perspective

The spacecraft simulator will be a standalone web application accessible through modern web browsers. It will utilize advanced physics and graphics engines to provide realistic simulations of spacecraft operations and mining techniques on Psyche.

2.2 Product Functions

- Simulate approach trajectories, landing maneuvers, and sample mining operations.
- Visualize mining operations and evaluate extraction techniques.
- Allow users to manipulate spacecraft parameters such as thrust, angle, and speed.
- Provide real-time data feedback and analysis based on user-defined scenarios.

2.3 User Classes and Characteristics

NASA Engineers: Require precise simulations for mission planning and design validation.

NASA Managers: Seek insights into project feasibility and resource allocation.

NASA Public Affairs Personnel: Need to communicate mission objectives to the public effectively.

Spacecraft Industry Engineers: Focus on design assessments and technology evaluation.

Scholars and Researchers: Require data for studies on asteroid characteristics and mining feasibility.

Mining Experts: Assess potential resource extraction methods and efficiencies.

Science Teachers: Use the simulator as an educational tool for teaching space science concepts.

General Public: Engage with simplified simulations for educational and recreational purposes.

2.4 Constraints

- A stable internet connection is required to access the simulator.
- The application must be compatible with major web browsers (Chrome, Firefox, Edge).
- Compliance with NASA's security and data management protocols is mandatory.

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3. Specific Requirements

3.1 Functional Requirements

User Authentication:

- Users must register and log in to access advanced features.
- Support for email verification and password recovery processes.

Simulation Control:

- Users can adjust parameters such as thrust, approach angle, landing speed, and mining tools.
- Include a “reset” function to return to initial settings.

Visualization:

- Real-time 3D rendering of spacecraft, asteroid Psyche, and mining activities.
- Feedback indicators for successful landings and mining operations.

Data Management:

- Users can save simulation scenarios and results for future reference.
- Capability to export data in various formats (CSV, PDF).

Educational Resources:

- Provide tutorials and guides on spacecraft dynamics and asteroid mining.
- Include interactive scenarios to demonstrate key concepts in space science.

3.2 Non-Functional Requirements

Performance: The simulator should maintain a minimum frame rate of 30 FPS to ensure smooth interaction.

Usability: The UI must be intuitive and user-friendly, accommodating users of varying expertise.

Scalability: The application should efficiently handle multiple users simultaneously without degradation in performance.

Security: Registered user data must be encrypted, and the application must comply with relevant data protection regulations.

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4. Use Cases

Use Case 1: User Registration and Login

- Users create an account and log in to access the simulator and its features, though an option will exist where a user may utilize the simulator as a guest, thus not requiring login.

Use Case 2: Running a Simulation

- Users select parameters and initiate simulations for approach, landing, and sample mining activities.

Use Case 3: Exporting Simulation Results

- Users can save and export their simulation results for further analysis and reporting.

Use Case 4: Accessing Educational Resources

- Users can browse and utilize tutorials and guides on spacecraft operations and mining techniques.

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5. Non-Functional Requirements

5.1 Performance

- The simulator shall maintain a minimum frame rate of 30 frames per second (FPS) during all operations to ensure smooth visualization and interaction.
- The system should load initial scenarios within 5 seconds to minimize user wait time.

5.2 Usability

- The user interface (UI) shall be intuitive and user-friendly, allowing users of varying expertise levels to navigate and operate the simulator with minimal training.
- The system should provide clear instructions and tooltips for all interactive elements to enhance user understanding.

5.3 Scalability

- The application shall support at least 500 concurrent users without performance degradation.
- The system must be designed to easily accommodate future enhancements or increased user load.

5.4 Security

- User data, including personal information and simulation results, must be encrypted both in transit and at rest to ensure data protection.
- The application shall comply with relevant data protection regulations (e.g., GDPR, CCPA) and NASA's security protocols.

5.5 Reliability

- The system should have an uptime of 99.5%, ensuring availability for users.
- In case of system failure, the application shall provide appropriate error messages and recovery options without data loss.

5.6 Compatibility

- The simulator shall be compatible with major web browsers, including Google Chrome, Mozilla Firefox, and Microsoft Edge, across various devices (desktops, laptops, tablets).
- The system must support the latest versions of these browsers to ensure optimal performance and security.

5.7 Maintainability

- The codebase should follow industry best practices to facilitate easy updates and maintenance.
- Documentation must be provided for both users and developers, including system architecture, user manuals, and troubleshooting guides.

5.8 Localization

- The application should support multiple languages, starting with English and Spanish, to cater to a diverse user base.
- The UI must be adaptable to different cultural contexts, ensuring usability across regions.

5.9 Accessibility

- The simulator shall adhere to Web Content Accessibility Guidelines (WCAG) 2.1 Level AA standards to ensure it is usable by individuals with disabilities.
- Features such as keyboard navigation, screen reader compatibility, and color contrast considerations must be implemented.