Software Requirements Specification

for

Trek VR Room

Version .1

Prepared by Lucca Andrade Guedes Galvao Coutinho, Fabio Carrasco, Enrique Guardado, Ruben Heredia, Ari Jasko, Bryan Lopez, Ly Jacky Nhiayi, Ayush Singh, Rizwan Vazifdar, Justin Vuong

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Revision History

Name	Date	Reason For Changes	Version

1. Introduction

1.1 Purpose

The purposes of this document are to:

1. Identify the requirements for The JPL Trek VR Room which will inform the reader on the purpose of the project, how the user can interact with the application, and how the application will interact with external services.
2. Describe and clarify functions of The JPL Trek VR Room.
3. Detail requirements that are necessary for the operation of The JPL Trek VR Room.

1.2 Intended Audience and Reading Suggestions

This document is for project managers, developers, users, document writers and people with some background in computer science. This includes staff, faculty, advisors, NASA JPL liaisons.

1.3 Product Scope

The JPL Trek VR Room is an open standard Virtual Reality (VR) application intended for the use of VR headsets. The software retrieves scientific data from Jet Propulsion Laboratory (JPL) TrekVR database. TrekVR database is a database that stores data of the terrain of celestial bodies. With the implementation of VR, the software will provide a ground perspective of these details. This shall be done through implementing a VR user interface through which the user shall be able to select a point of interest (POI) in the celestial body. Once POI is selected, users shall be displayed data pertaining to this POI. As well as the function to observe data on paths through the celestial body. This will be done through the use of a VR headset that will allow the user to turn head and face in different directions as well as control component hands.

The objective is to create an application that visualizes the datasets from the VRTrek database. Software will be used for research and education purposes.

1.4 Definitions, Acronyms, and Abbreviations

Refer to Appendix A

1.5 References

Title: Software Requirements Specification for Augmented Reality for Hydrology
Authors: Wilbert Veit, Christopher Hung Nguyen, Ernesto Padilla, Cuong Pham, Kaichen Zhou
Date: October 28, 2022
(This was used as a reference as an example of how to write an SRS document)

Title: Virtual Reality system for Planetary Surface Visualization and Analysis
Author: Alvin Quach
Date: July 09, 2019

2. Overall Description

2.1 Product Perspective

The goals we aim to solve with JPL VR tech room are to provide a software where users can have a full visualization of different planets/Satellites that NASA has on their database. This information can be used for research purposes for scientists or can be used by the general public. This application can also be used for education purposes. Professors or grade school teachers could use this application to teach their students about the environment of Mars.

The JPL VR Techroom was created using OpenXR, and the software was programmed with C# and Unity. We created JPL VR techroom to provide a software where users can have a full visualization of different planets/Satellites that NASA has on their database. Users will be able to pick which plants they want to be displayed and they will be able to use several functions of the JPL VR Techroom to calculate the distance between 2 points on the planet and have other information that NASA has on the planet.

2.2 Product Functions

2.2.1 Display Planet Function
2.2.1.1 Display different levels of exaggerated terrain to the user
2.2.1.2 Able to rotate planet in live time through the vr headset controllers
2.2.1.3 Display Area selection onto a flat plane which the user can examine
2.2.1.4 Display elevation profile of a given path drawn by the user on the planet
2.2.2 Retrieve Planet Data Function
2.2.2.1 Measure distance between any 2 points on the moon
2.2.2.2 Measure area between any an enclosed area on the moon

2.3 User Classes and Characteristics

Main users are scientists, students, and people who wish to access the VR room. All users will be the same and will have similar access to different data from the moon or Mars. Each user will be able to explore Mars using the NASA API and see it through a virtual reality headset.

2.3.1 Scientists
2.3.1.1 Scientists may have an anticipated use for scientific research.

2.3.1.2 Scientists may have a high level of frequency of use.
2.3.1.3 Scientists may have a high level of education.
2.3.2 Teacher/Instructors
2.3.2.1 Instructors may have an anticipated use for educational purposes.
2.3.2.2 Instructors may have a mid-level of frequency of use.
2.3.2.3 Instructors/teachers have a high level of education.
2.3.3 Students
2.3.3.1 Students have an anticipated use for educational purposes under the guidance of a Teacher.
2.3.3.2 Students may have a low level of frequency of use.
2.3.3.3 Students have a low level of education.
2.3.4 General Audience
2.3.4.1 General Audience have an anticipated use for personal purposes
2.3.4.2 General Audience may have a low level of frequency of use.
2.3.4.3 General Audience may have a variety of education when using JPL Trek VR.

2.4 Operating Environment

2.4.1 The software will run on any compatible computer
    2.4.1.1 Compatible hardware is specified in section 3.2
    2.4.1.2 The software will run on SteamVR application
    2.4.1.3 The software will run on Windows operating system
2.4.2 The software will need a stable internet connection.
2.4.3 The software will need Windows
2.4.4 The software will need Steam

2.5 Design and Implementation Constraints

2.5.1 Weak/Unstable Network Connectivity - May cause issues in retrieving data from api calls
    2.5.1.1 Weak connection may cause errors while displaying the moon in real time
    2.5.1.2 Weak connection may result in data not displaying correctly
    2.5.1.3 Weak connection may result in textures not loading correctly
2.5.2 Interfaces With Other Applications - Need stable connectivity in order to retrieve data from the database using JPL API.

2.5.3 Device Storage - Needed for caching large amounts of data retrieved from the database.

2.5.3.1 Storage will be stored within the software

2.5.4 Device Performance - Need adequate performance from devices to render computer-generated objects.

2.6 User Documentation

Documents will include slides, code, system requirements document, and system design document. Users can use these documents to get a better idea of how The JPL VR tech room application works.

2.7 Assumptions and Dependencies

2.7.1 User is expected to have a stable internet or wifi connection to retrieve data from the getDistance, getArea, and getHeightProfile.

2.7.1.1 User is expected to have a recommended minimum of 25 mbps of internet speed

2.7.2 User is expected to have an internet browser installed.

2.7.3 User is expected to have an Meta Quest 1, 2 or HTC Vive

2.7.4 User is expected to have either Windows operating system or Steam and SteamVR downloaded

3. External Interface Requirements

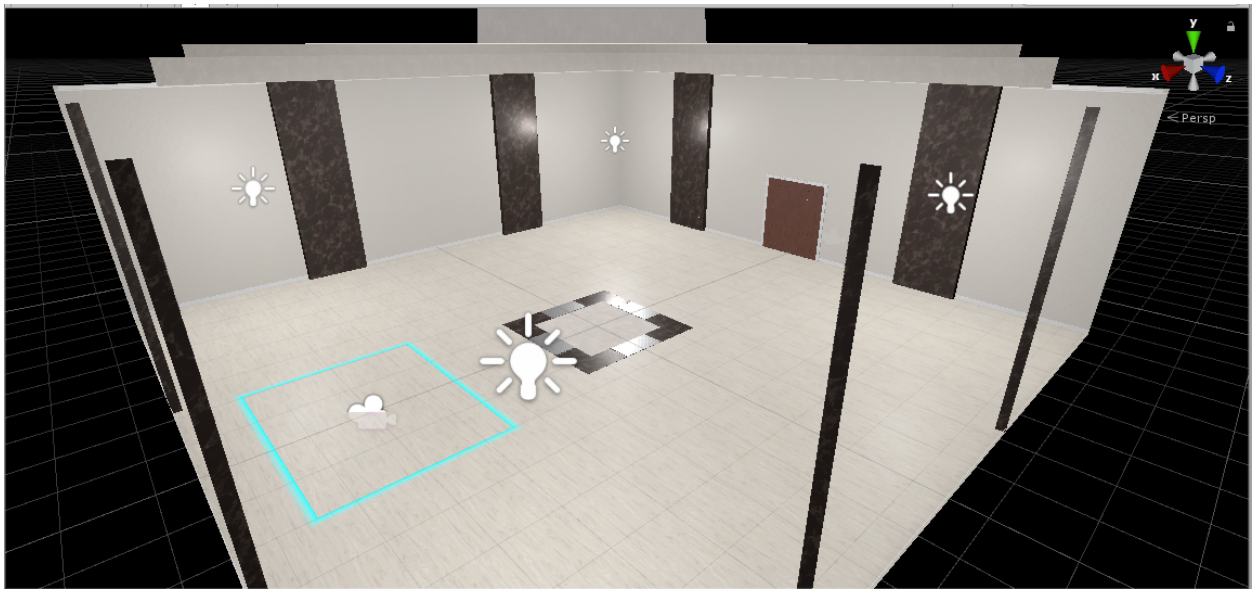
This section of the document is for the users that would like to use The JPL VR Trek software. In this section, there will be a description of how the user can interact with the software.
Non-technical users of this application should be prompted to this section of the document.

3.1 User Interfaces

3.1.1. Initialization : The user is placed in a virtual reality room where they will be able to access a table that shows the terrains of the Moon/Mars.

3.1.2. Display Settings
- 3.1.2.1. Texture - Change terrain type
- 3.1.2.2. Coordinates - Show the coordinate plane on the globe.
- 3.1.2.3. Location Names - Show the name of the locations.
- 3.1.2.4. Terrain Exaggeration - Scale the realism in terrain exaggeration accordingly.

3.1.3. Menu
- 3.1.3.1 Search - Allows the user to select the following options:
  - 3.1.3.1.1. Bookmarks - Users can create a bookmark to a specific location
  - 3.1.3.1.2. Nomenclatures - Additional option
  - 3.1.3.1.3. Products - Different data types stored in the database
- 3.1.3.2 Tools - Allows the user to use the following tools:
  - 3.1.3.2.1. Area Selection - shows an area provided by the sides
  - 3.1.3.2.2. Distance - User can add points and return the distance between points
  - 3.1.3.2.3. Elevation - Allows user to see the elevation represented on a graph
  - 3.1.3.2.4. Layer Manager - Add a new layer. Search or view existing layers
- 3.1.3.3. Options - Provides more options



3.2 Hardware Interfaces

3.2.1. Computer devices with internet access and graphics card(s) are supported.
3.2.2. Users will need VR headset (Oculus Quest 2 and HTC VIVE)
3.2.3. Recommended to use Windows as the Operating System
3.2.4. Recommended for the user to have 4gb RAM on their system.
3.2.5. Processor**:** Intel i5-4590 / AMD FX 8350 equivalent or greater.
3.2.6. Graphics**:** NVIDIA GeForce GTX 970 / AMD Radeon R9 290 equivalent or greater.

3.3 Software Interfaces

3.3.1. JPL VR Trek uses the Unity Game Engine.
3.3.1.1. Allows the development and implementation of our 3D model in the Trek VR room.
3.3.2. JPL VR Trek uses OpenXR.
3.3.2.1. Provides AR/VR software development, core pose prediction, frame timing, and spatial input functionality.
3.3.3. JPL VR Trek uses C#
3.3.3.1. Language used to implement front and back-end api and interfaces.
3.3.4. JPL VR Trek uses Trek API
3.3.4.1. These API calls were executed:
3.3.4.2. Calculate Distance
3.3.4.2.1. Calculates the distance over a series of points.

3.3.4.3. Elevation Profile

3.3.4.3.1. Calculates the elevations over a series of points.

3.3.4.4. Sun Angle

3.3.4.4.1. Calculates the sun angle on a point over a duration of time.

3.4 Communications Interfaces

3.4.1. Steam

3.4.1.1. The application shall be able to be used on steam.

3.4.2. HTTP communication

3.4.2.1. The application shall use HTTP to handle requests and responses.

3.4.3. Server communication

3.4.3.1. The application shall be able to have the client send a request to the server and the server sends a response back to the client.

3.4.4. TrekVr application portal

3.4.4.1. The application shall require internet connection to make API calls to the JPL server.

4. Requirements Specification

4.1 Functional Requirements

4.1.1. Users must be able to host a collaborative session using the application.

4.1.1.1. The application should display all objects in the scene to all the users in the same session.

4.1.1.2. The application should allow users in a session to share the same 2D/3D planet/satellite surface.

4.1.1.3. The application should include a text messaging interface for users in session.

4.1.1.4. Users should be able to invite other users to their session using the application.

4.1.2 The application must have tools for marking up the 2D/3D planet/satellite surface.

4.1.2.1. Users should be able to project 2D/3D text onto the planet/satellite terrain using the application.

4.1.2.2. The application should have a free-hand drawing annotation tool.

4.1.3 Users must be able to establish interactive navigation markers on 2D/3D planet/satellite surface using the application.

4.1.3.1. Users should be able to modify/delete navigation waypoints in the application.

4.1.3.2. Users should be able to draw polylines with the different waypoints.

4.1.4 Users must be able to save the current Trek room state.

4.1.4.1. The application should allow the user to extract all markups and annotations and save them for future use.

4.1.4.2. The application should enable the user to extract data from a surface layer and store it for later use.

4.1.4.3. The application should allow the user to import markups and annotations to be displayed in the current session.

4.1.4.4. The application should allow the user to import layer data to be displayed in the current session

4.2 External Interface Requirements

4.2.1. The following hardware devices are compatible with the application:

4.2.1.1. Meta Quest

4.2.1.2. HTC Vive

4.3 Logical Database Requirements

4.3.1. Types of information used by various functions

- Session data
- Layer data

- Coordinate data
- Text data
- Waypoint data
- Raster Subsets
- Map image and tables

4.3.2 Frequency of use

- Data is retrieved at least once at the beginning of the session to retrieve the base model.
- Data is then retrieved based on each host request made throughout the session.

4.3.3 Accessing capabilities

- The user can access any data available through the JPL Trek server and convert it into an easily formattable file by specifying its data type.

4.3.4 Data entities and their relationship

- All data is retrieved as a query result object and saved as references to the desired information set as a “Document” object publicly available.
- Saved information can then be retrieved at any time and downloaded or converted into their desired data type.

4.3.5 Integrity constraints

- NASA's Trek Data must be supported by the database.

4.3.6 Data retention requirements

- During each session, data should be stored temporarily.
- Users should be able to access previously stored session data from the current session using the application.

4.4 Design Constraints

4.4.1 Unstable Internet Connectivity.

4.4.1.1 Slow or unstable upload/download internet speed might cause issues when running the application

4.4.2 Device Storage.

4.4.2.1 Low disk storage may cause problems.

4.4.3 Device Performance.

4.4.3.1 Outdated computer hardware that does not meet the required specifications may cause the application to run poorly.

5. Other Nonfunctional Requirements

5.1 Performance Requirements

5.1.1 To deliver the frame rates required for a comfortable experience, virtual reality requires high-performance computer hardware.

5.1.2 Meta Quest 2 Recommended Specifications

- 5.1.2.1 Processor: Intel i5-4590/AMD Ryzen 5 1500X or greater
- 5.1.2.2 Graphics Card: GeForce Nvidia 9 series and above
- 5.1.2.3 Memory: 8GB or more of RAM
- 5.1.2.4 Operating System: Windows 10
- 5.1.2.5 USB port: 1x USB port

5.1.3 HTC Vive Recommended Specifications

- 5.1.3.1 Processor: Intel Core i5-4590/AMD 8350 equivalent or better
- 5.1.3.2 GPU: NVIDIA GeForce GTX 1060, AMD Radeon RX 480 equivalent or better
- 5.1.3.3 Memory: 4GB RAM or greater
- 5.1.3.4 Video Output: Compatible HDMI 1.4, DisplayPort 1.2 or newer
- 5.1.3.5 USB port 1x USB 2.0 or newer
- 5.1.3.6 OS: Windows 7 SP1, Windows 8.1 or later, Windows 10

5.2 Safety Requirements

5.2.1 Users are expected to be aware of their surroundings.

5.2.2 Users are expected to follow age guidelines set by the virtual reality headset manufacturer.

5.2.3 Users are expected to respond appropriately to warnings shown on the screen.

5.2.4 Users are not recommended to handle sharp objects while using the headset.

5.2.5 Users are not recommended to use the headset in situations that require attention.

- 5.2.5.1 Driving
- 5.2.5.2 Biking
- 5.2.5.3 Walking or running

5.2.6 Users are not permitted to use an unauthorized headset

- 5.2.6.1 Users must input a valid login to use a headset

5.2.7 Users are not recommended to use the headset when motion is impared.

- 5.2.7.1 Do not use the headset when tired
- 5.2.7.2 Do not use the headset when sick
- 5.2.7.3 Do not use the headset when under emotional distress

5.2.8 Users with medical conditions are recommended to see a doctor before using the headset.

5.3 Security Requirements

5.3.1 Personal information such as credit card information that is used for any online service associated with a Trek product is encrypted via secure socket layer technology.

5.3.2 Account information for online interactions with other users is protected by a password system.

5.3.3 Ensure data input into the application is protected.

- 5.3.3.1 Body Movement Tracking
- 5.3.3.2 Financial Data
- 5.3.3.3 Personal Data

5.3.3.4 Protection against DDOS attacks.

- 5.3.3.4.1 Employ Content Distribution Networks
- 5.3.3.4.2 Employ a Web Application Firewall
- 5.3.3.4.3 Utilize extensive network interfaces to increase server capacity

5.3.3.5 Protection against malware.

- 5.3.3.1 Anti-virus software is strongly recommended to avoid headsets being hacked.

5.4 Software Quality Attributes

5.4.1 Product should be dependable, and the logic within the views model should contain correct logic for properly displaying data.
5.4.2 As long as the database is not down, the product should always be available, and it should always receive the proper data.
5.4.3 Product should be testable in order to thoroughly test all of the project's functionalities while it is in development.

5.5 Business Rules

5.5.1 The product will be accessible to any user.

5.5.2 Personal data will not be sold, rented, or traded to any third party without the explicit consent of the user.

5.3.3 NASA content is not copyright protected and the data inside the application may be utilized for educational and information purposes without the explicit consent of JPL.

6. Legal and Ethical Considerations

Discuss any legal and/or ethical issues involved in the project. Justify the decisions made based on legal and/or ethical principles.

One of the primary ethical considerations the team took into account was the user's safety. It is essential to understand that if a user runs a virtual reality program, their vision will be focused on the media in their headsets. The user's safety is essential to take into account in this situation because the program should assist the user in staying in a safe space without getting hurt.

Appendix A: Glossary

- JPL : (Jet Propulsion Laboratory) is a research and development lab federally funded by NASA and managed by Caltech.
- OpenXR: An open, royalty-free standard for access to virtual reality and augmented reality platforms and devices.
- HTTPS: (Hypertext Transfer Protocol) an application layer protocol in the Internet protocol suite model for distributed, collaborative, hypermedia information
- OS: (Operating-system) is system software that manages computer hardware, software resources, and provides common services for computer programs
- API: (Application programming interface) a connection between computers or between computer programs. It is a type of software interface, offering a service to other pieces of software

Appendix B: Analysis Models

Appendix C: To Be Determined List