Indian Institute of Information Technology Allahabad

Software Requirement Specification

on

3D Terrain Rendering using WebGL

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1. Introduction

This report has been created with the aim to provide Software Requirements Specification (SRS) report for the "Mobile-based Large 3D Terrain Rendering using OpenGL with the Grand Canyon Terrain Dataset."

1.1 Purpose of the Document

The Software Requirements Specification (SRS) document outlines the detailed requirements for the development of a mobile-based application focusing on large-scale 3D terrain rendering. This application leverages the capabilities of OpenGL, a graphics library, to create realistic and immersive visualizations. The primary dataset for this project is the Grand Canyon Terrain Dataset, chosen for its complexity and real-world relevance.

1.2 Scope of the Project

The scope of the project encompasses the development of a mobile application capable of rendering expansive 3D terrains in real-time. The goal is to provide users with a visually compelling and interactive experience, allowing them to explore and navigate through a virtual representation of the Grand Canyon terrain on their mobile devices.

1.3 Overview of 3D Terrain Rendering

3D terrain rendering is a specialized field within computer graphics that involves the creation of lifelike three-dimensional representations of landscapes. By incorporating elevation data, surface textures, lighting, and shadows, the objective is to simulate natural environments with a high degree of realism. The focus on terrain rendering adds an additional layer of complexity, requiring careful consideration of geological features and real-world accuracy.

1.4 Importance of Mobile-based Rendering

The decision to target mobile platforms for this project is driven by the ubiquity of mobile devices and the increasing demand for on-the-go applications with visually rich content. By bringing large-scale 3D terrain rendering to mobile devices, we aim to democratize access to realistic visualizations and offer an engaging experience to a broad user base.

1.5 Objectives

The primary objectives of this project include:

- Developing a mobile application for 3D terrain rendering.
- Leveraging the OpenGL graphics library for efficient rendering.
- Utilizing the Grand Canyon Terrain Dataset for realistic and data-driven visualizations.

1.6 Target Audience

The intended audience for this document includes developers, designers, project stakeholders, and any parties involved in the development, testing, or deployment of the 3D terrain rendering application.

1.7 Document Structure

The remainder of this document is organized to provide a comprehensive understanding of the requirements, design considerations, and specifications for the development of the mobile-based 3D terrain rendering application. Sections include detailed system requirements, architectural design, user interface specifications, and testing procedures.

2. General Description

This general description section provides an overview of the Mobile-based Large 3D Terrain Rendering application, outlining user objectives, key features, and the significance of the project for different user communities. Adjustments and specific details can be made based on the unique aspects of your project and stakeholder expectations.

2.2 User Objectives

2.2.1 User Characteristics

The primary users of the application include enthusiasts, researchers, and individuals interested in exploring the Grand Canyon virtually. Users are expected to have a basic familiarity with mobile applications and an interest in geography, geology, or virtual exploration.

2.2.2 Features

- Real-time 3D Rendering: Utilizing OpenGL to provide users with a dynamic and responsive experience, rendering the Grand Canyon in intricate detail.
- Terrain Information Overlay: Displaying real-world data and information about geographical features, enhancing the educational and informational aspects of the application.
- Interactive Elements: Incorporating interactive elements to engage users, such as points of interest, annotations, and additional contextual information.

2.3 Importance

The importance of the Mobile-based 3D Terrain Rendering application lies in its ability to bring realistic and educational experiences to users' fingertips. By utilizing the Grand Canyon Terrain Dataset, the application offers a unique opportunity to virtually explore one of the world's most iconic natural wonders. The mobile platform ensures widespread accessibility, allowing users to access the application anytime, anywhere.

2.4 Features of User Community

2.4.1 Enthusiasts

Enthusiasts, including nature lovers, hikers, and travelers, can use the application to explore and plan visits to the Grand Canyon, gaining insights into its terrain and landmarks.

2.4.2 Researchers

Researchers in geography, geology, and environmental science can leverage the application for educational and research purposes, studying the Grand Canyon's geological features remotely.

2.4.3 Educators

Educators can integrate the application into classroom settings, offering students an immersive learning experience about geographical formations and natural landscapes.

3. Requirement Analysis

3.1 Functional Requirement

3.1.1 Navigation Controls:

- Users should be able to navigate the virtual Grand Canyon terrain using touch gestures, including pinch-to-zoom, swipe for panning, and rotate for changing viewpoints.
- The application should provide on-screen controls for additional navigation options.

3.1.2 Real-time Interaction:

- Real-time interaction with the rendered terrain, ensuring responsive feedback to user input.
- Integrate intuitive controls for zooming, panning, and rotating to enhance user exploration.

3.1.3 Terrain Rendering

- The app should render the 'Grand Canyon' terrain dataset in a 3D environment.
- The terrain should be procedurally generated to provide a varied and realistic landscape.
- The terrain rendering should incorporate continuous level of detail system to optimize performance.
- The terrain should support single-plane texture and light mapping for enhanced visual quality.

3.1.4 Forest Generation

- The app should generate forests within the terrain based on predefined rules.
- The forest generation should consider terrain features and provide realistic placement of trees and vegetation.

3.1.4 Static Mesh Loading and Rendering

- The app should support loading and rendering of static meshes such as additional objects and structures on the terrain.
- The static meshes should be seamlessly integrated into the terrain environment.

3.1.5 Animated Water

- The app should simulate simple animated water bodies within the terrain.
- The water animation should provide a realistic representation of water movement and reflections.

3.1.6 Customizable Settings Menu

- The app should provide a settings menu that allows users to customize various aspects of the terrain simulation.
- The settings menu should include options for adjusting terrain generation parameters, forest density, water animation, and other relevant settings.

3.1.7 Qt Quick Integration

- The app should integrate Qt Quick for the user interface, providing an intuitive and user-friendly experience.
- The user interface should allow users to navigate the terrain, access settings, and interact with the various features of the app.

3.2 Non-functional Requirement

3.2.1 Frame Rate Optimization:

- Achieve a minimum frame rate of 30 frames per second (fps) for smooth rendering on mobile devices.
- Optimize rendering algorithms to ensure efficient performance**.**

3.2.2 Loading Time:

- Ensure that the application loads within 5 seconds on standard mobile devices.
- Implement progressive loading to enhance user experience during initial rendering**.**

3.2.3 Intuitiveness:

- Ensure that navigation controls and interactive elements are intuitive for users with basic familiarity with mobile applications.
- Minimize the learning curve for first-time users.

3.2.4 User Engagement:

- Maximize user engagement through visually appealing rendering and interactive features.
- Maintain a balance between informative content and an immersive user experience.

3.3 System Requirement

3.3.1 Platform Compatibility

Android : Version 8 and above.

3.3.2 Device Compatibility

Mobile Devices:

- Compatibility with a variety of smartphones and tablets.
- Consideration for different screen sizes and resolutions.

3.3.3 Hardware Requirements

Minimum Hardware Specifications

Processor: Quad-core processor or equivalent.

Minimum 1.5 GHz clock speed.

Minimum 2 GB RAM.

OpenGL ES 3.0 support.

3.4. Data and Resource Management

3.4.1 Data Storage

3.4.1.1 Application Storage

- Minimum 100 MB free space for application installation.
- Additional storage for caching and storing user preferences.

3.4.1.2 Offline Data Storage

Capability to store a portion of the Grand Canyon Terrain Dataset for offline use.

3.5 Network Connectivity

3.5.1 Network Requirements:

- Internet connectivity for initial data download and updates.
- Graceful handling of intermittent network connectivity.

4. Design

Terrain Rendering process:

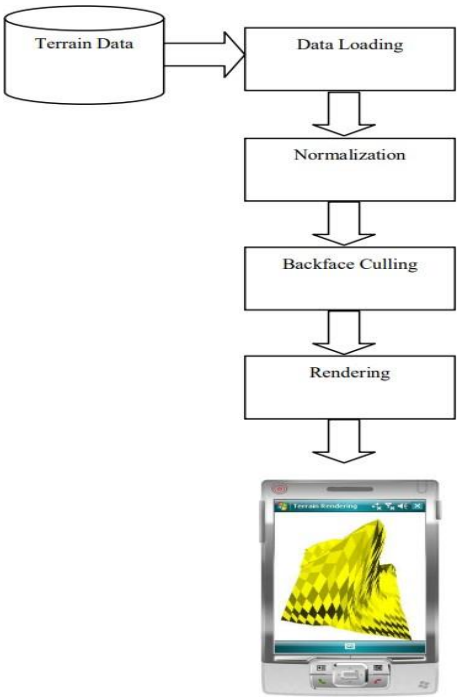

Fig. 1: General Process for Rendering Terrain on Mobile Device

Pipeline

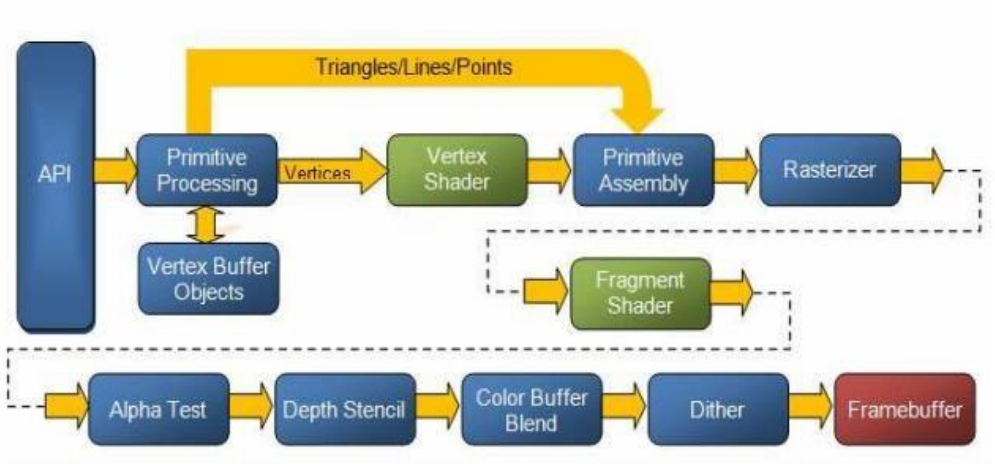

Fig. 2 : OpenGL ES 1.X fixed pipeline

Appearance of Terrain in Mobile Devices

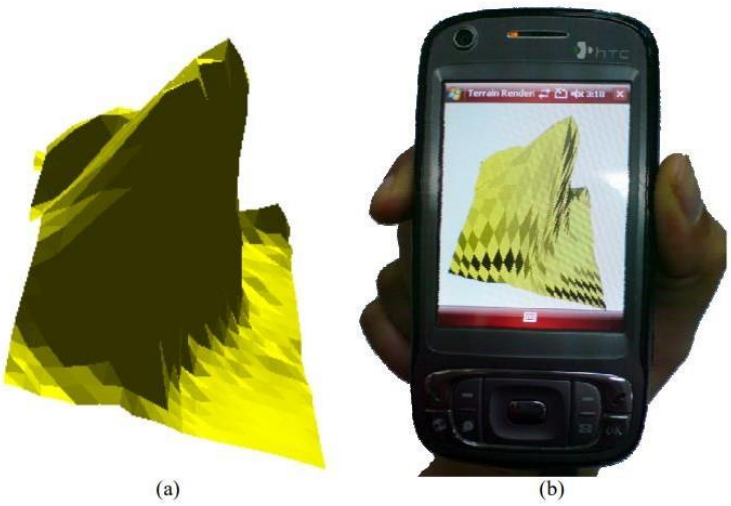

Fig. 3 : Example view of terrain in mobile device

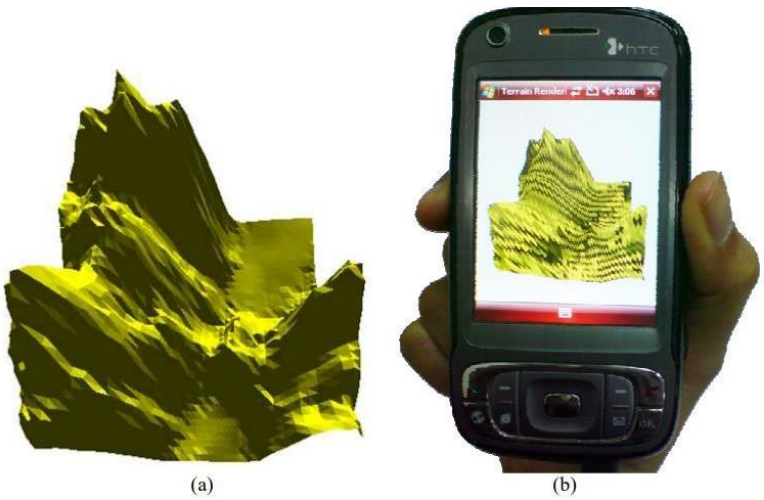

Fig. 4 : Example view of terrain in mobile device

5. Constraint

Design constraints are limitations or restrictions that influence the design and implementation of a system. In the context of a "Mobile-based Large 3D Terrain Rendering using OpenGL with the Grand Canyon Terrain Dataset," here are some possible design constraints:

5. 1 Hardware Limitations

Processing Power: The rendering performance might be constrained by the processing power of mobile devices. The application needs to optimize rendering algorithms for various hardware specifications.

5.2 Memory

Limited RAM on mobile devices may impose constraints on the size of the terrain dataset and the level of detail that can be rendered.

5.3 Graphics Capabilities

The availability of OpenGL ES 3.0 support on the target devices is crucial. The application needs to adapt to different graphics capabilities on various mobile devices.

Network Connectivity:

The application may require periodic updates or additional data retrieval. Designing for intermittent network connectivity is essential to ensure uninterrupted functionality.

5.4 Screen Size and Resolution

The diversity in screen sizes and resolutions among mobile devices requires the application to be responsive and scalable, adapting to different display characteristics.

5.5 Battery Consumption

Rendering complex 3D terrains can be resource-intensive and impact battery life. The application should aim for energy-efficient rendering to minimize battery consumption.

5.6 Data Transfer Limitations

Large terrain datasets or high-resolution texture maps may pose challenges in terms of download size. The application needs to consider potential limitations on data transfer, especially for users on limited data plans.

5.7 Accessibility

Designing for accessibility is a constraint to ensure that the application is usable by individuals with disabilities. This includes considerations for screen readers, color contrast, and other accessibility features.

5.8 Security and Privacy

Handling user data and ensuring secure communication with external servers, especially when retrieving additional terrain data, is a critical design constraint. User privacy and data security must be prioritized.

5.9 Regulatory Compliance

Compliance with app store regulations and guidelines, as well as any regional or international regulations related to data handling and privacy, is a constraint that should be adhered to during design.

5.10 Localization

The application may need to support multiple languages to cater to a diverse user base. Designing for localization includes considerations for translated text, cultural differences, and date/time formats.

5.11. Educational Content Accuracy

If the application includes educational content about the Grand Canyon, there is a constraint to ensure the accuracy of the information presented. Information should align with geological and geographical facts.

5.12. User Interface Design Guidelines

Adherence to the design guidelines of the respective mobile operating systems (iOS Human Interface Guidelines or Android Material Design) is a constraint for maintaining a consistent and familiar user experience.

6. Conclusion

In conclusion, the "Mobile-based Large 3D Terrain Rendering" app offers an exciting exploration of the 'Grand Canyon' on mobile devices. With features like realistic terrain and customizable settings, it provides a diverse and engaging experience. Looking forward, potential enhancements include improved realism, personalization, global terrain exploration, and augmented reality features. While costs depend on complexity, investing in these improvements can elevate the app's appeal and innovation in mobile 3D terrain exploration.

7. References

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