Master's thesis

Integrating High Fidelity Mapping Services Into Public Presentations

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Abstract

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Chapter 1

Introduction

Scientific visualization of space research, also known as astro-visualization, becomes increasingly important for scientists to communicate their work in exploring the cosmos. 3D computer graphics has shown to be an efficient tool for bringing insights from geological and astronomical data, as spatial and temporal relations can intuitively be interpreted through 3D visualizations.

Researching and mapping out celestial bodies other than the Earth is an important part of expanding the space frontier and virtually rendering these globes using real gathered map and terrain data is a natural part of any scientifically accurate space visualization software.

Two important parts of a software for visualizing celestial bodies are terrain and atmosphere. The focus of this thesis is put on terrain rendering on globes using high fidelity geographical data such as texture maps and digital terrain models. The globe rendering feature with the research involved was implemented for the software OpenSpace. The implementation was separated enough from the main program to avoid dependencies and make the thesis independent of specific implementation details.

1.1 Background

1.1.1 OpenSpace

OpenSpace is an open-source, interactive data visualization software with the goal of bringing astro-visualization to the broad public and serve as a platform for scientists to talk about their research. The software supports rendering across multiple screens, allowing immerse visualizations on tiled displays as well as in dome theatres [1].

With a real time rendering software such as OpenSpace, the human curiosity involved in exploration easily becomes obvious when the user is given the ability to freely fly around in space and near the surface of other worlds and discover places they probably never can visit in real life. This is also true for public presentations where researchers such as geologists can go into details about their knowledge in these places.

An important part of the software is to avoid the use of procedurally generated data. This is to express where the frontier of science and exploration is currently at, and how it progresses through space missions with the goal of mapping the Universe. A general globe browsing feature provides a means of communicating this progress through continuous mapping of our planets and moons.

1.1.2 Globe Browsing

¡Sub-subsection title¿

even more text[1], and even more.

1.2 Motivation

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Chapter 2

Theoretical Background

A sophisticated globe rendering system needs to rely on some mathematical foundations. These foundations together with different theories and algorithms developed for globe rendering works as a base for the research of this thesis.

2.1 Modelling Globes

We will discuss different proposed methods used for modelling and rendering of globes. The globe can be modelled either as a sphere or an ellipsoid and there are different tessellation schemes for meshing the globe. Different map projections can also be considered and it all ties together with a choice of level of detail algorithm.

Planets, moons and asteroids are generally more accurately modelled as ellipsoids than as spheres. Planets are often stretched out along their equatorial axes due to their rotation which causes the centripetal force to counter some of the gravitational force acting on the mass. This effect was proven in 1687 by Isac Newton in Principia Mathematica [13]. The rotation causes a self-gravitating fluid body in equilibrium to take the form of an oblate ellipsoid, otherwise known as a biaxial ellipsoid with one semimajor and one semiminor axis. Globes can be modeled as triaxial ellipsoids for more accuracy when it comes to smaller, more irregularly shaped objects. For example Phobos, one of Mars's two moons, can be modeled as a triaxial ellipsoid with radii of $27 \times 22 \times 18$ km [2].

The World Geodetic System 1984 (WGS84) standard defined by National Geospatial-Intelligence Agency (NGA) models the Earth as a biaxial ellipsoid with a semimajor axis of 6,378,137 m and a semiminor axis of 6,356,752.3142 m [2]. This is what is known as a reference ellipsoid; a mathematical de-

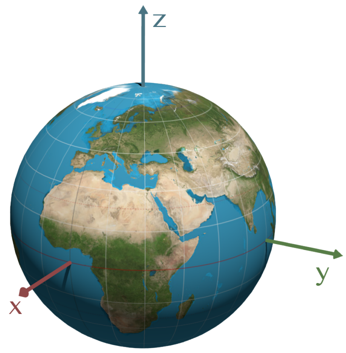

Figure 2.1: The WGS84 coordinate system and globe.

scription that approximates the geoid of the earth as closely as possible. The WGS84 standard is widely used for GIS and plays an important role in accurate placements of objects such as satellites or spacecrafts with position coordinates relatively close to the Earth's surface. In the WGS84 coordinate system, the x-axis points to the prime meridian, the z-axis points to the north pole and the y-axis completes the right handed coordinate system, see figure 2.1.

Chapter 3

implementation

3.1 ¡Section title¿

3.1.1 ¡Sub-section title¿

3.1.2 ¡Sub-section title¿

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Figure 3.1: ¡Caption here¿

3.1.5 ¡Sub-section title¿

3.2 ¡Section title¿

Chapter 4

Results

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Chapter 6

Future Work

¡Future work here¿

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Chapter 7

Appendices