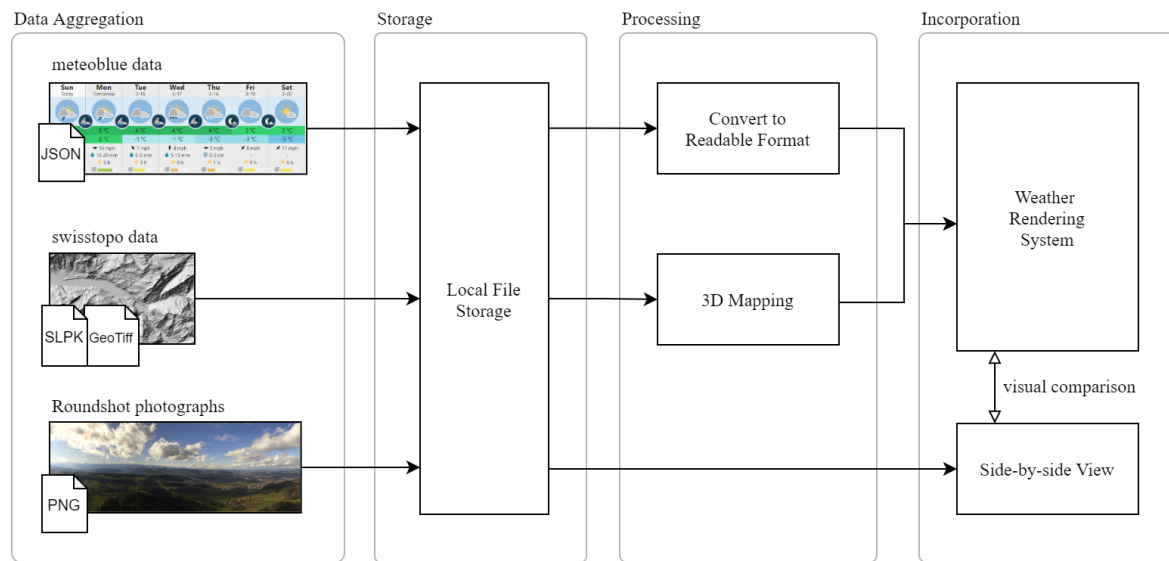


Real-time Cloud Rendering System

Project documentation



Field of Studies:	BSc in Computer Science
Specialization:	Computer perception and virtual reality
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Date:	March 25, 2021
Version:	1.0

Abstract

Clouds contribute a great deal to the overall ambience in games and can be the cherry on top by filling the sky with life. To get as close as possible to real clouds, this project engages in researching and prototyping a procedural, volumetric cloud shader.

In order to achieve , the document dives into the concept of ray marching, a group of methods used to render a 3D data set inside a container box to make it appear volumetric. Several variants of it are expanded on, like constant step, traditional, and sphere-traced ray marching. Additionally, to account for perception of depth, the volume can be shaded with the aid of surface normal estimation.

In the second part, 2D and 3D noise generation algorithms like Perlin's noise and the Voronoi algorithm are explained in detail. With fractal Brownian motion, the different layers of noise are then merged into one highly detailed noise texture.

At last, the goal of the project was to create prototypes in Unity displaying both volumetric rendering and noise algorithms, of which all were created successfully. Prepared with the combined knowledge of the research results and prototypes, a final shader was created, able to render a completely procedural and volumetric cloudscape.

For future work, the shader could be expanded into a fully-fledged weather simulation system with meteorologically accurate formation of clouds, rain, snow and much more.

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1 General

1.1 Purpose

During this project, all gathered information and knowledge about the researched algorithms and techniques are written down. All prototypes and the final results are documented and compared with real photographs of clouds.

1.2 Audience

This document is written with the intent to further expand existing knowledge about the topic, hence it requires a fundamental knowledge about computer graphics and rendering.

1.3 Revision History

Version	Date	Name	Comment
0.1	March 25, 2020	Matthias Thomann	Initial draft

Glossary

Fractal Brownian motion Different iterations of continuously more detailed noise layered on top of each other. [i](#)

Noise A randomly generated pattern, referring to procedural pattern generation. [i](#)

Procedural Created solely with algorithms and independant of any prerequisites. [i](#)

Ray marching Ray marching is a type of method to approximate the surface distance of a volumetric object, where a ray is cast into the volume and stepped forward until the surface is reached. [i](#)

Surface normal A *surface normal* or *normal* is a vector which is perpendicular to a given geometry, like a triangle or polygon. [i](#)

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