n|w University of Applied Sciences and Arts Northwestern Switzerland
School of Architecture, Civil Engineering and Geomatics

MSE | MASTER OF SCIENCE IN ENGINEERING

Interactive Real Time 3D-Rendering of Large Cities

This study explores the generation of realistic renders using Unreal Engine 5.1, specifically focusing on the implementation of the Nanite and Lumen Global Illumination System modules. Open data from swisstopo, including elevation models, orthophotos, and building data, is utilized to construct a georeferenced virtual world. Real-world models, such as laser-scanned surveys, can be integrated, along with future project designs. The workflow is partially automated through Python code. The research confirms the feasibility of generating these renders and identifies areas for further development, such as unifying the Python code within Unreal Engine and creating a web interface for enhanced project sharing.
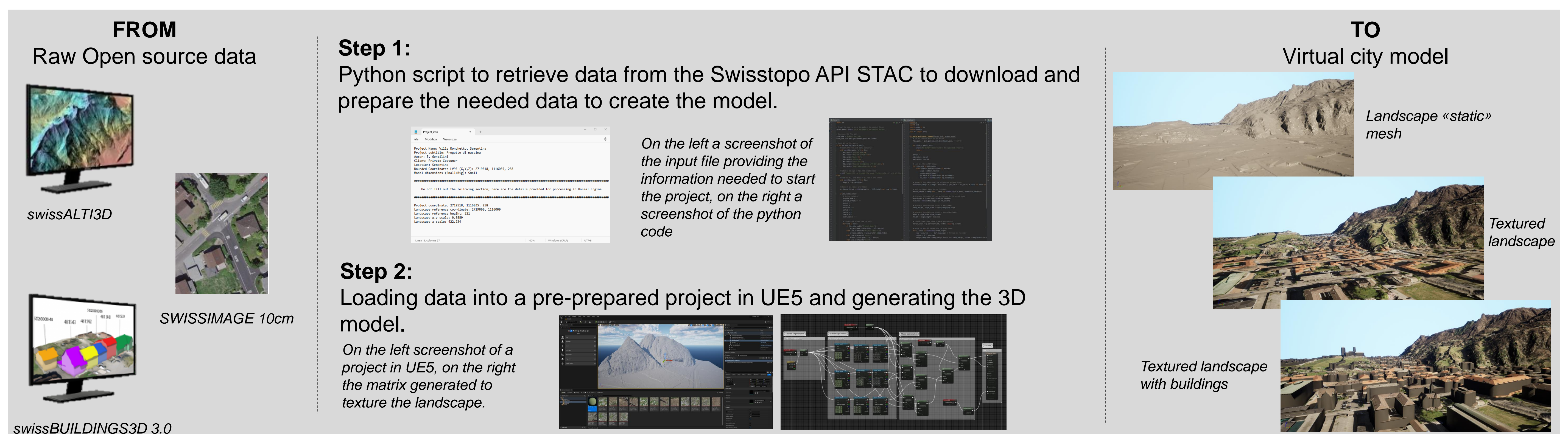
Introduction

This project aims to address the challenges of processing and visualizing highly detailed 3D models in design, architecture, and urban planning. By analyzing Unreal Engine 5 (UE5), a graphics engine primarily used in video games, we explore its potential for generating and visualizing 3D city models on standard computers. Our focus is on UE5's Nanite format for mesh processing and the Lumen global illumination system for lighting management. We integrate open-source data and detailed elements from drone and laser scanner surveys. The objective is to develop a process for converting 3D city models into the Nanite format and evaluate the performance of Lumen for real-time rendering in large urban environments. This research showcases Unreal Engine 5's broader applications and its significance in spatial planning and geomatics.

Render «view from the sky of Bellinzona, with integration of a 3D project on the field of the «Castel Grande»

Workflow

FROM
Raw Open source data

swissALTI3D

SWISSIMAGE 10cm

swissBUILDINGS3D 3.0

Step 1:
Python script to retrieve data from the Swisstopo API STAC to download and prepare the needed data to create the model.

On the left a screenshot of the input file providing the information needed to start the project, on the right a screenshot of the python code

Step 2:
Loading data into a pre-prepared project in UE5 and generating the 3D model.

On the left screenshot of a project in UE5, on the right the matrix generated to texture the landscape.

TO
Virtual city model

Landscape «static» mesh

Textured landscape

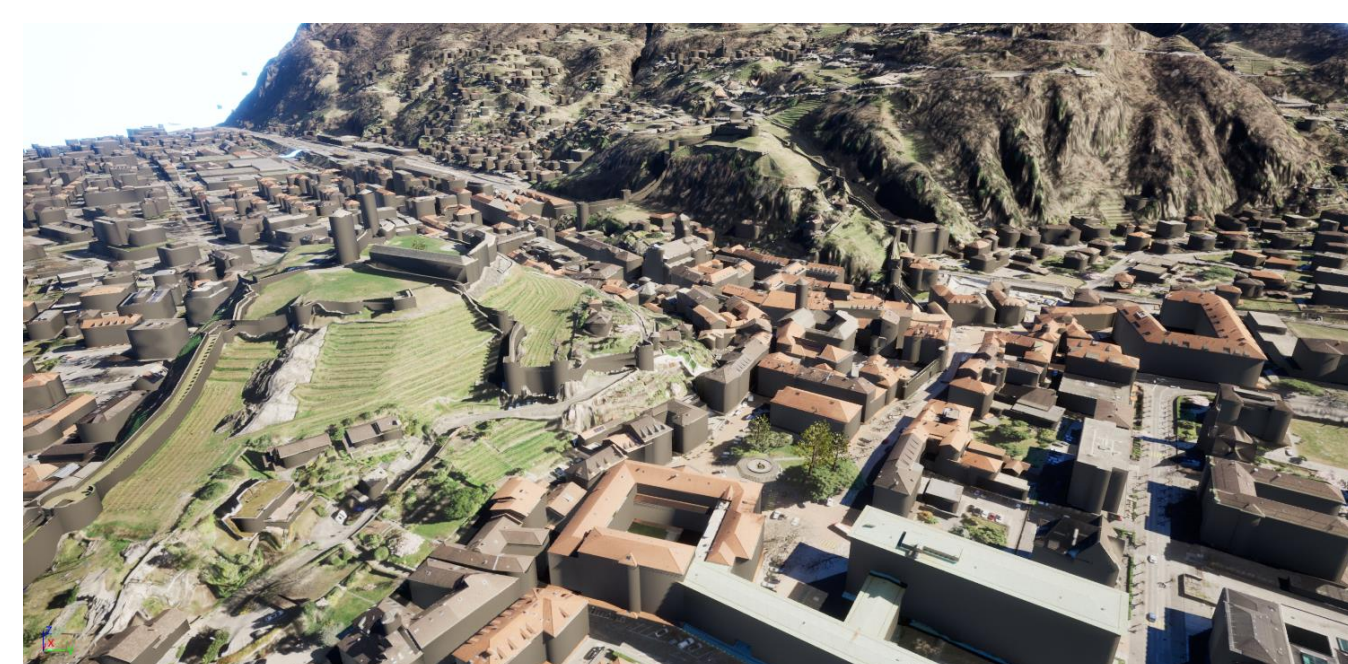*Textured landscape with buildings*

Results

The results of this project can be categorized into four distinct areas, each demonstrating the capabilities and applications of the rendering techniques employed.

1) General Renders of Cities and Landscapes

Through the utilization of advanced rendering methods, the project offers visually impressive representations of urban environments and expansive landscapes.
These renders display architectural elements, terrain features, and atmospheric effects, providing an holistic view of the environments. The combination of realism and immersion enables users to explore and evaluate the overall context with exceptional fidelity.

«Piazza della foca» in Bellinzona

2) Renders of Surveyed Real Objects with High Details

By employing advanced scanning techniques, the project excels in capturing real-world objects with meticulous detail. High-resolution models of surveyed objects are translated into visually striking renders, facilitating in-depth analysis and visualization. This level of accuracy allows for a comprehensive understanding of the objects' in reference to the surrounding area.

Render of Bellinzona, view from the sky

3) Renders of Real Projects (New House)

Renders of new houses and architectural developments showcase the design intent, material properties, lighting conditions, and contextual aspects. These can be integrated in to the "base model", giving a relation from the project to the real environment where it will be realized. This level of realism enables stakeholders and decision-makers to evaluate and assess proposed projects in an immersive and accurate manner, leading to informed design choices, not only on the object but in the real context.

Idea of a new bridge in Mesocco

4) Renders of Ideas

Additionally, the project utilizes rendering to visualize and communicate conceptual ideas and design explorations. These renders serve as a medium for creative discussions and the exploration of design possibilities. By effectively conveying intended aesthetics and design intent, these renders foster the refinement of ideas and generate valuable insights for further development.

Idea of a new bridge in Mesocco

Conclusion:

Through the diverse range of results presented, this project demonstrates the power and versatility of advanced rendering techniques in capturing and visualizing various subjects using a graphic engine. From detailed real-world objects to architectural designs and abstract concepts, the project's rendering capabilities open up exciting opportunities for scientific visualization, design evaluation, and creative exploration in numerous fields using practically only open source or self acquired data and a graphic game engine.

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Image source: Swisstopo website and own screenshots.