Voxelizing Google Earth: A Pipeline for New Virtual Worlds

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Figure 1. A voxelized version of city streets in Paris, France, created using our pipeline to convert Google Photorealistic 3D Tiles into voxels.

Abstract

This paper presents Voxel Earth, a novel pipeline for automatically converting Google Maps Photorealistic 3D Tiles into voxels, enabling the creation of interactive virtual worlds in Minecraft, web browsers, and VR environments. Our approach addresses the challenge of represSenting the Earth's geography in voxel-based platforms, offering a scalable and dynamic solution that preserves detail and accuracy. We discuss the technical challenges, applications, and future directions of this technology, highlighting its potential to revolutionize digital earth representation and enhance our understanding of the planet's diverse landscapes.

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1 Introduction

The rapid evolution of digital mapping technologies has facilitated novel ways of visualizing and interacting with geographic data. Voxel Earth[1] introduces a novel approach to transforming Google Photorealistic 3D Tiles into voxels for use in Minecraft, web browsers, and virtual reality (VR) environments. This method significantly advances the automation of Earth representation in voxel-based platforms, offering a way to artistically view our world.

Previous research has explored the creation of virtual worlds using geographic data. Müller et al. [2] proposed procedural modeling techniques for generating 3D city models, while Xu et al. [3] developed a voxel-based approach for 3D point clouds.

However, these approaches have not focused on the automatic conversion of large-scale, high-resolution geographic data into voxels, which is the primary focus of Voxel Earth.

The main contributions of this paper are threefold. First, we propose a novel pipeline for automatically converting Google's 3D Tiles into voxels, enabling the creation of interactive virtual worlds. Second, we develop optimization techniques to efficiently manage the vast scale of the data involved, ensuring the pipeline can handle the entire Earth's geography without sacrificing detail or accuracy. Finally, we demonstrate the potential applications of Voxel Earth across education, urban planning, architecture, and entertainment, showcasing the practical benefits of our approach.

2 Methodological Innovations

Voxel Earth's core innovation lies in its automated pipeline for converting Google Photorealistic 3D Tiles into voxels. The process begins by selecting high-resolution 3D Tiles that accurately represent the Earth's geography. These tiles are then decomposed into a grid of voxels, each representing a specific volume of space.

The voxelization algorithm assigns color and material properties to each voxel based on the original photogrammetry data, ensuring a faithful representation of the real-world appearance. An ML algorithm then maps the voxels to Minecraft blocks, considering environmental context to recreate natural and urban landscapes accurately within the game. This mapping preserves the functionality of the Minecraft environment, with water bodies represented by water blocks and vegetation mapped to appropriate plant blocks.

We note that the only previous work in this area is a large project called "Build the Earth", which requested the manual labor of thousands to build out their cities inside of Minecraft [1]. By using a pipeline to convert photogrammetry to Minecraft voxels, we trim those millions of manual labor hours down significantly. We show our results as a Minecraft sample, a browser-viewable map, through VR, and several famous locations voxelized as art.

[1] voxelearth.org

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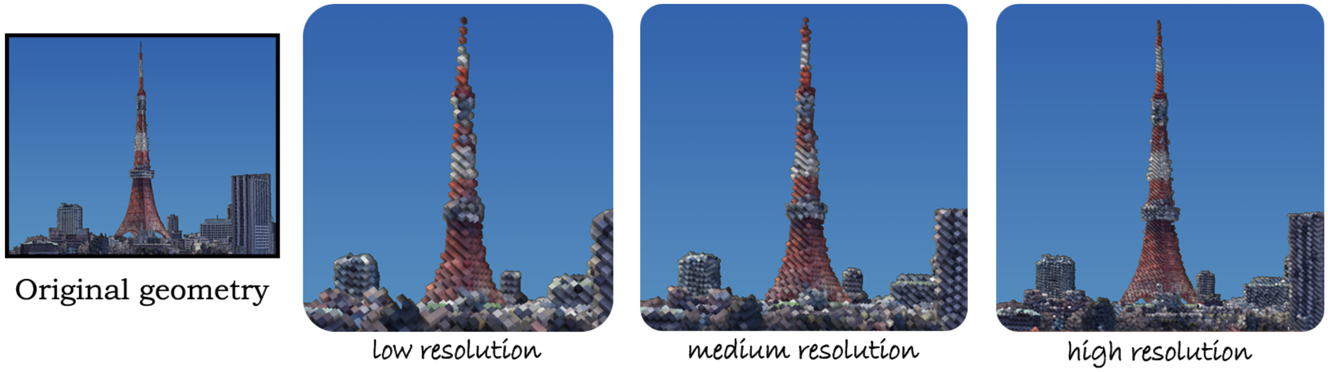

Figure 2. A comparison of low, medium, and high resolution voxelizations of Tokyo Tower. Adjusting the voxelization resolution provides flexibility for different use cases and enables storage and computation savings.

Figure 3. UT Austin Tower voxelized at high resolution.

Figure 4. UT Austin Tower voxelized at low resolution. Lowering voxel resolution represents the same structure with less data.

Figure 5. An aerial view of the voxelized Cornell Tech campus.

3 Technical Challenges and Solutions

One of the primary technical challenges we faced was the vast scale of the data involved. Google's comprehensive global coverage means that converting the entire Earth into voxels requires processing enormous quantities of data. To address this challenge, we developed optimization techniques that streamline the voxelization process, such as parallel processing and data compression methods with native voxel-based files, allowing us to manage the data efficiently without sacrificing detail or accuracy. In the Minecraft samples, we only voxelize new 3D Tiles as they load.

To ensure our voxel models remain up-to-date and abide by Google's no-cache policy, our voxel models are always based on the latest on-demand 3D Tiles, ensuring changes in the physical geography are accurately reflected in the digital models.

4 Applications and Future Directions

Voxel Earth has numerous applications across education, urban planning, architecture, and entertainment. It provides an engaging platform for teaching geography and environmental science, allows professionals to simulate and visualize urban development projects, and offers a unique tool for collaborative design processes.

Looking forward, we aim to improve urban management and art with voxel-based compression and rendering techniques. As the coverage of 3D Tiles expands, so too will the scope and detail of the virtual worlds we can create with Voxel Earth.

Voxel Earth represents an advancement in digital earth representation, providing a scalable, dynamic, and unique method for exploring and interacting with the planet's geography. By automating the conversion of Google's 3D Tiles into voxels, we open up new possibilities for understanding and appreciating the Earth.

5 Acknowledgments

We use data from Google Maps. © 2024 Google LLC, under fair use.

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