

電機資訊學院 2026 實作專題競賽 BRAIN PLUS HAND

Interactive Large-Scale 3DGS Map via NVIDIA Omniverse Streaming

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Introduction

We present a novel streaming framework for interactive visualization of large-scale 3D Gaussian Splatting (3DGS) models, enabling smooth, real-time exploration on resource-constrained devices like mobile phones. Leveraging NVIDIA Omniverse Kit on an RTX 5090 GPU server, our backend efficiently renders complex 3DGS scenes (e.g., 50M Gaussians, 8 GB) to a Three.js-based frontend using WebRTC for low-latency interaction. We enhance scene interactivity with metadata annotations from an Unreal Engine 5 tool, incorporating building bounding boxes and navigation paths sourced from OpenStreetMap. Our approach achieves a stable 30 FPS on diverse devices, a 7-30x performance improvement over direct Three.js rendering (1-4 FPS on high-end laptops, unfeasible on mobiles), making large-scale 3DGS models accessible for applications like urban planning and virtual tours without requiring powerful client hardware.

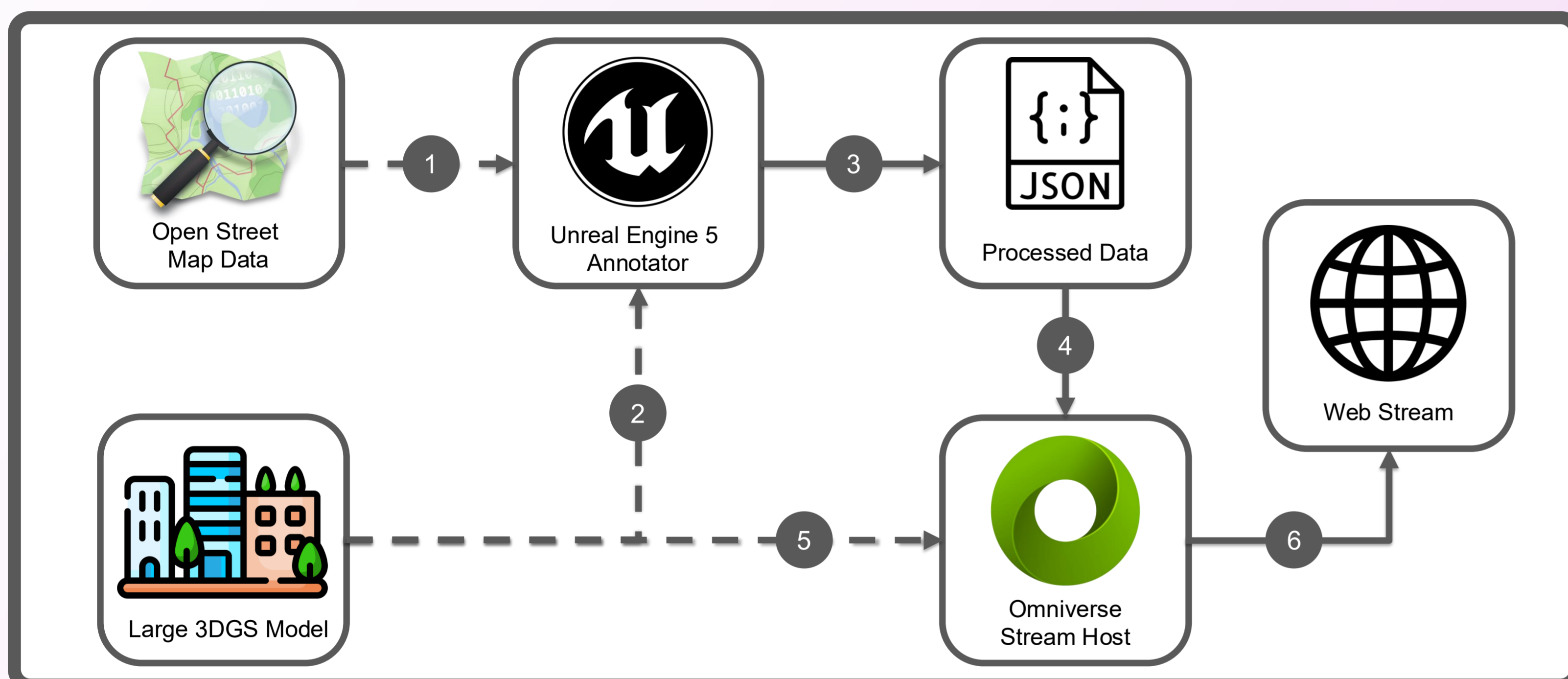


Fig. 1. Our framework takes 3DGS model (1) and OSM data (2) as inputs for UE5 Annotator, allow user to modify data. The data is then preprocessed into JSON format (3). The Omniverse Stream Host takes the processed metadata (4) and 3DGS model (5), enabling users to stream the 3DGS model (6).

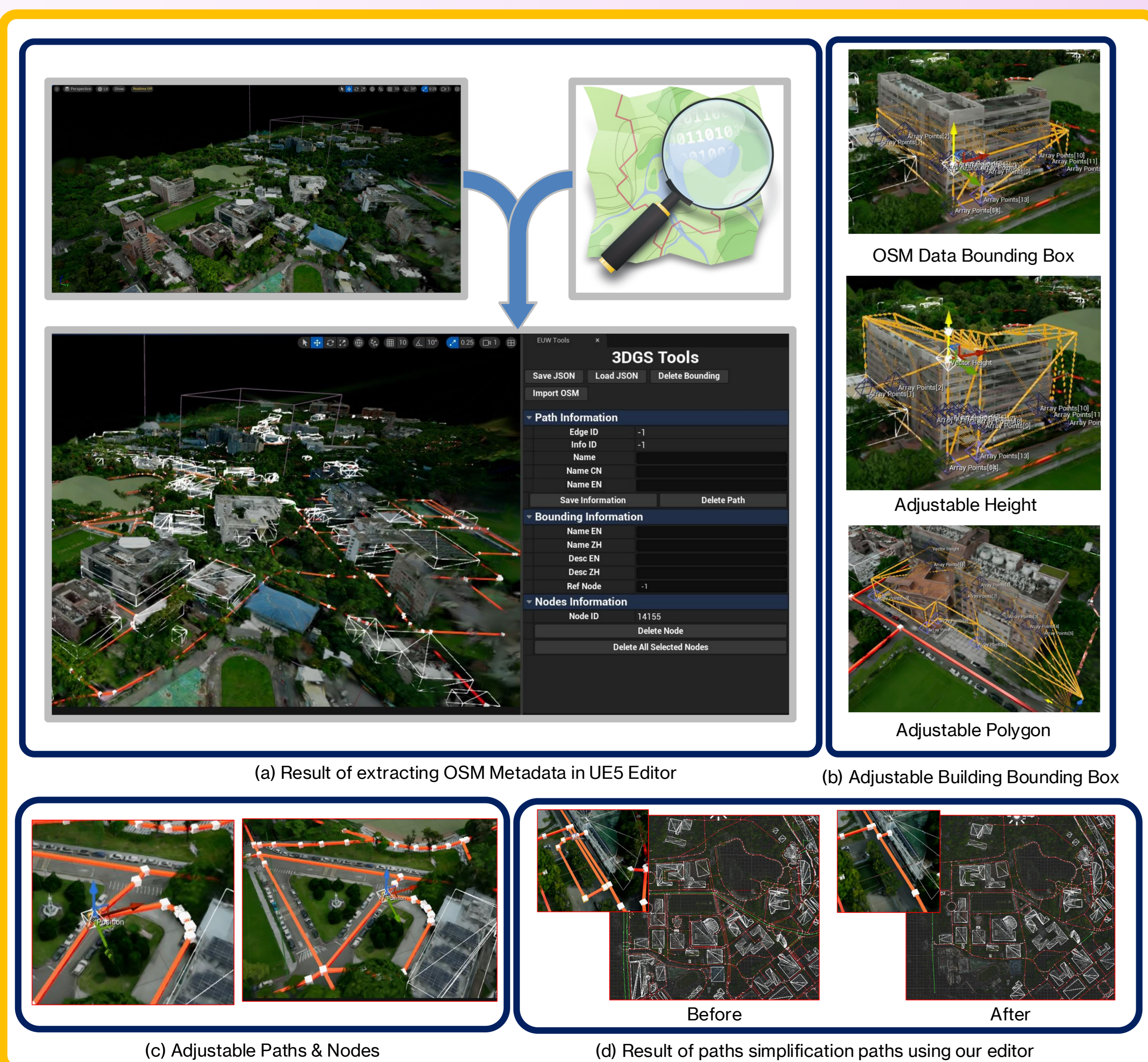


Fig. 2. Users can interact with path nodes to modify edges and bounding box locations within 3D scenes. In the right panel, users can also edit the semantic data associated with buildings and navigation paths.



Fig. 3, 4. Aerial views of a campus environment rendered with a large-scale 3D Gaussian Splatting model, showcasing detailed terrain, buildings, and vegetation, with overlaid annotations and a navigation path highlighted.

Methodology

The Unreal Engine Powered Annotator

This tool enables the creation and editing of building bounding volumes, navigation paths, and other spatial annotations. It supports direct import of OSM data to improve alignment in real-world outdoor environments. The system also maintains graph metadata from OSM, keeping it synchronized with user edits and easily integrable for navigation metadata editing.

The NVIDIA Omniverse Powered Streaming System

Our streaming system, powered by NVIDIA Omniverse Kit, renders large-scale 3D Gaussian Splatting (3DGS) models on an RTX-accelerated GPU server and streams high-fidelity output via WebRTC to a Three.js frontend, with real-time camera pose synchronization. It supports local client-side rendering for lightweight cases and server-side streaming for intensive tasks, enabling scalable, photorealistic 3D experiences across diverse devices without overburdening client hardware.

Conclusion

Our streaming framework addresses the challenges of rendering large-scale 3D Gaussian Splatting interactive models by leveraging NVIDIA Omniverse Kit and Unreal Engine 5 annotations. This approach significantly enhances accessibility for urban planning and virtual tours, offering a high performance boost over traditional methods.