OmniRoam: World Wandering via Long-Horizon Panoramic Video Generation

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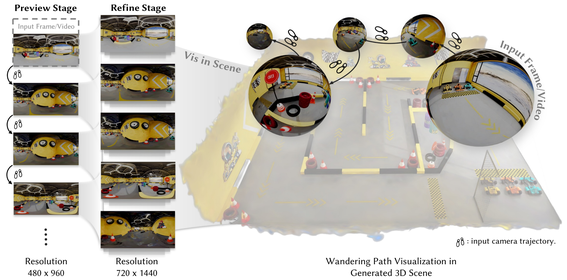
GITHUB WEBSITE PAPER

01 OVERVIEW

OmniRoam is a controllable panoramic video generation framework for long-horizon world wandering. It operates directly on **360° panoramas**, whose holistic coverage preserves global spatial memory across long trajectories, using a **global-to-local preview → refine** design that first lays out coarse scene structure, then progressively refines local detail for coherent, high-fidelity immersive exploration.



1. **Global-to-local framework** for controllable long-horizon panoramic video generation via a preview–refine design.
2. **Panoramic representation wins:** panoramas + decomposed trajectory control beat perspective methods on quality, controllability & long-term consistency.
3. **Scalable data pipeline & dataset** with precise camera trajectories, covering real handheld and synthetic 3DGS scenes.
4. **Loop Consistency:** a new metric for long-horizon global spatial coherence over closed-loop trajectories.

02 DATASET & BENCHMARK

REAL Scene-Reality
~2,000 handheld panoramic videos (**~5M** frames); gravity-aligned, COLMAP trajectories.

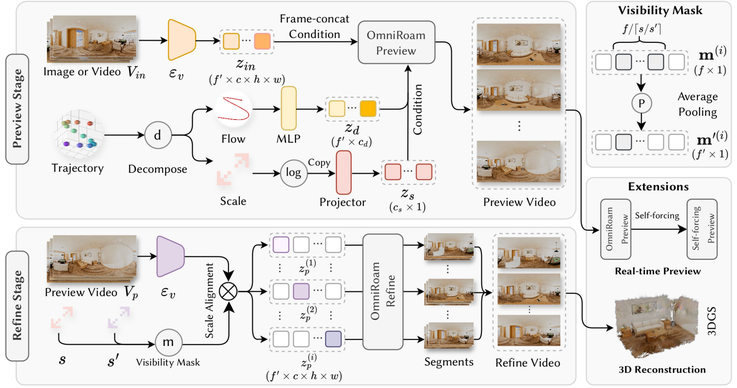
SYNTH Trajectory-Precise
1,000 3DGS scenes (InteriorGS) with physically-feasible camera paths.

03 RESULTS

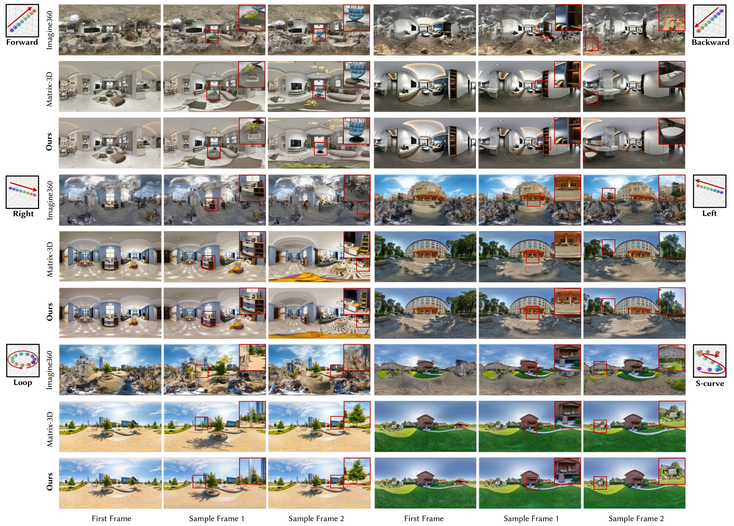
Method	Res	FAED↓	SSIM↑	LPIPS↓	PSNR'25↑	Loop↑
Matrix- 3D	480p	8.64	0.63	0.37	19.05	1.38
Imagine360	480p	23.35	0.33	0.61	–	–
Ours	**480p**	**5.27**	**0.70**	**0.18**	**23.06**	**2.34**
Ours	**720p†**	**5.07**	**0.66**	**0.33**	**19.75**	**1.96**

† Long-horizon 641-frame sequences. **Ours leads on every metric** (visual quality, trajectory controllability & loop consistency), and sustains it over long videos.

04 METHOD



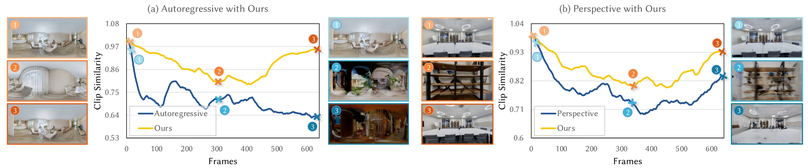
05 QUALITATIVE COMPARISON



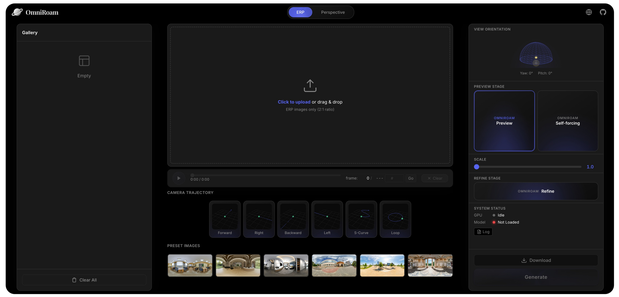
06 LOOP CONSISTENCY

$$C_{loop} = \frac{1 - S_2}{1 - S_1}$$

A new metric for whether a scene returns to its initial view after a closed loop. Ours (yellow) stays coherent & recovers; baselines (blue) drift.



07 OMNIROAM STUDIO



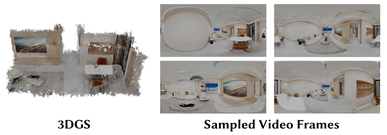
An interactive app to explore any panorama: upload an ERP image, choose a camera trajectory, set the playback scale, then **generate → preview → refine**. It supports a real-time self-forcing preview and one-click export.

08 DOWNSTREAM TASKS

A Real-time preview

A distilled **self-forcing** previewer synthesizes an 81-frame panorama in **~7 s**.

B 3D reconstruction



Sampled frames are cropped to perspective views and fused into a **3DGS** scene.

Code & project page: github.com/yuhengliu02/OmniRoam