Precise 3D modeling tech restores cultural properties with high resolution and unparalleled accuracy
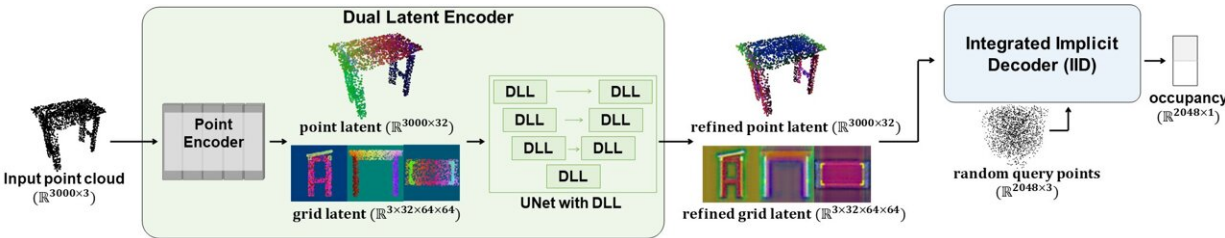
June 28 2024, by JooHyeon Heo

Figure 1. Overview of DITTO. Credit: *arXiv* (2024). DOI: 10.48550/arxiv.2403.05005

3D reconstruction technology has become an integral part of our daily lives and various industries, and UNIST's research team has continued to advance its development. Known as DITTO (Dual and Integrated Latent Topologies), the precise 3D modeling technology developed by Professor Kyungdon Joo and his research team in the Graduate School of Artificial Intelligence at UNIST has opened up new possibilities for the restoration of cultural heritage properties.

DITTO leverages the strengths of both point cloud and grid methods to reconstruct object shapes, converting point cloud data into a grid and leveraging both data simultaneously to extract important information. The Dynamic Spare Point Transformer (DSPT) analysis tool is used to

precisely analyze point cloud data and extract features that can accurately model complex and thin objects.

This [technology](#) has demonstrated significant potential for improving 3D modeling accuracy in various industries, such as medicine, robotics, and virtual reality. Based on the extracted data, the Integrated Implicit Decoder (IID) predicts whether a specific location in 3D space is inside or outside an object, enabling more accurate and detailed 3D reconstruction compared to existing technology.

The improved 3D modeling technology also has the potential to precisely restore damaged or deteriorated cultural heritage properties, preserving their original forms and details. According to Professor Kyungdon Joo, "This study goes beyond simply increasing the accuracy of 3D reconstruction and presents a new method for utilizing 3D data in various technologies. This will be a [valuable tool](#) for industries such as metaverse and CAD/CAE as a whole."
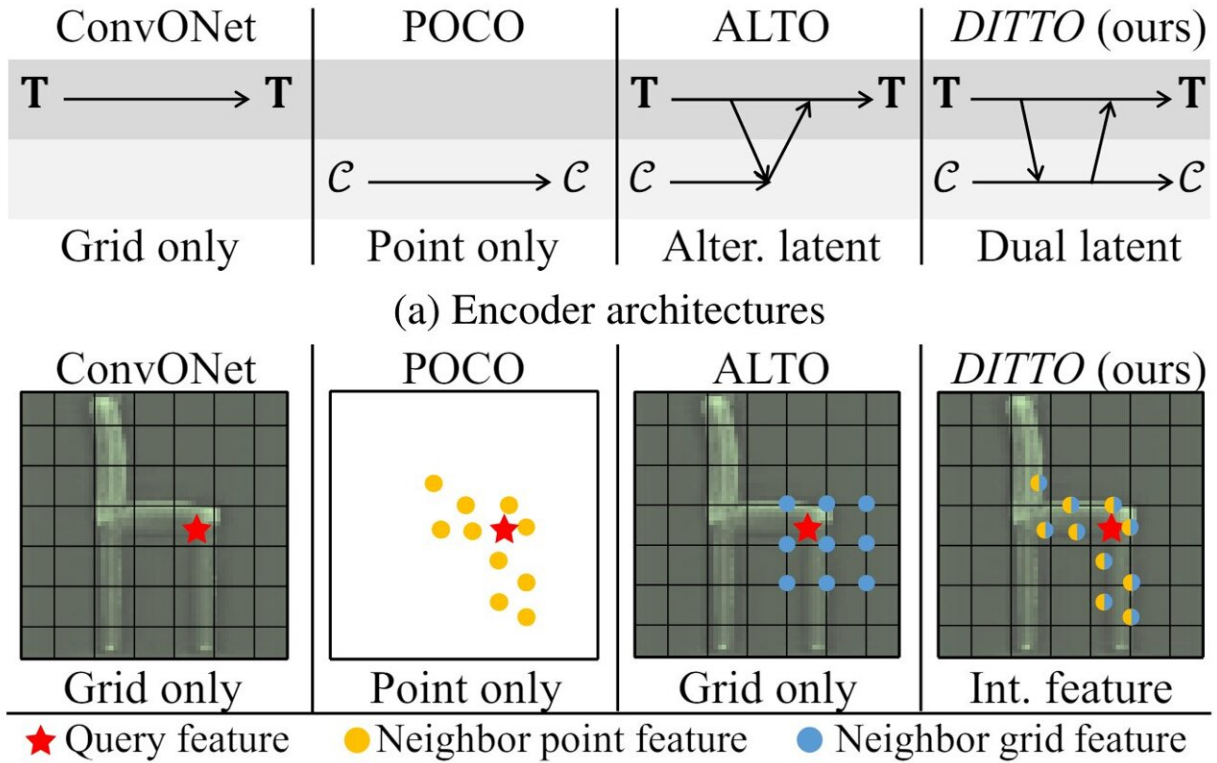
ConvONet	POCO	ALTO	*DITTO* (ours)
T ⟶ **T**	$\mathcal{C}$ ⟶ $\mathcal{C}$	**T** ⟶ **T** $\mathcal{C}$ ⟶	**T** ⟶ **T** $\mathcal{C}$ ⟶ $\mathcal{C}$
Grid only	Point only	Alter. latent	Dual latent

(a) Encoder architectures

ConvONet	POCO	ALTO	*DITTO* (ours)
Grid only	Point only	Grid only	Int. feature

★ Query feature   ● Neighbor point feature   ● Neighbor grid feature

Figure 2. Conceptual comparison of DITTO. Credit: Credit: *arXiv* (2024). DOI: 10.48550/arxiv.2403.05005

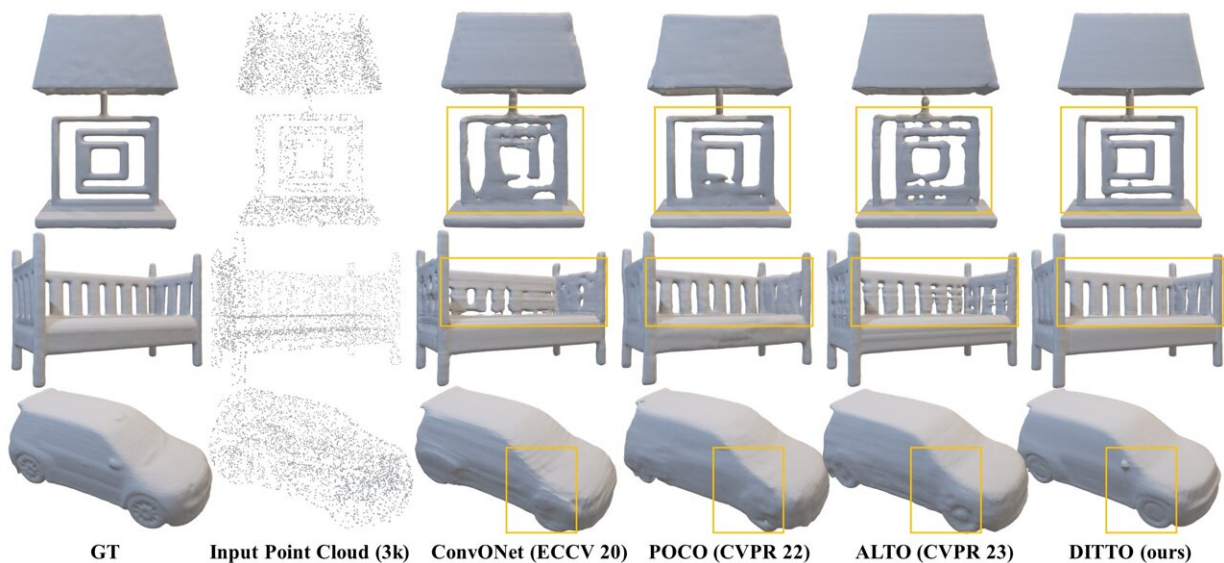| GT | Input Point Cloud (3k) | ConvONet (ECCV 20) | POCO (CVPR 22) | ALTO (CVPR 23) | DITTO (ours) |

Figure 3. Object-level 3D reconstruction comparison on ShapeNet with 3K input points. Credit: *arXiv* (2024). DOI: 10.48550/arxiv.2403.05005
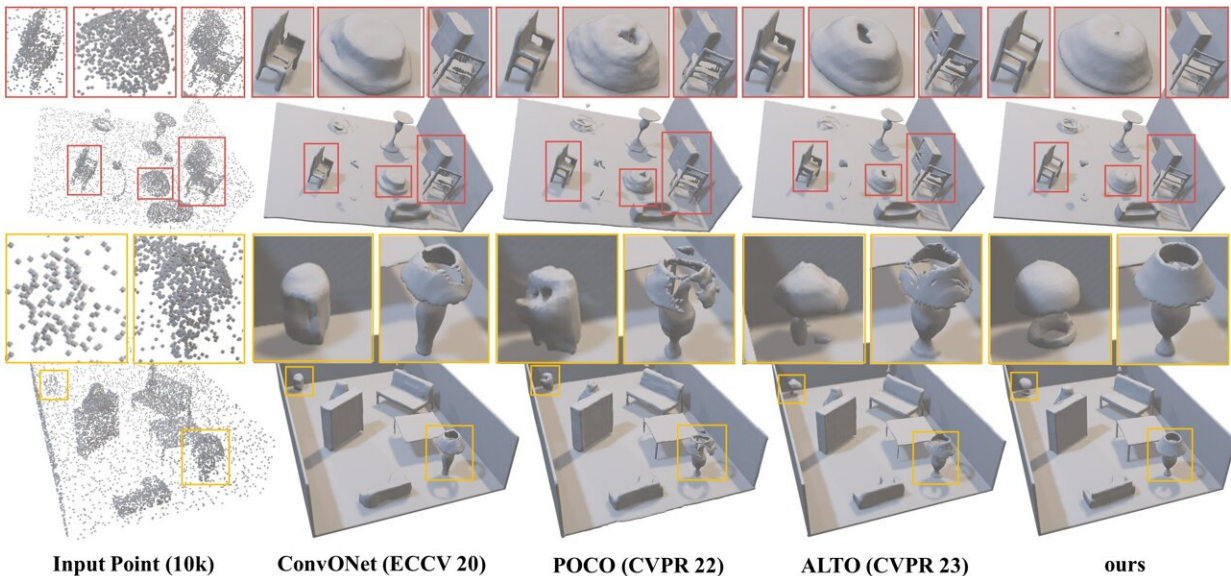

Figure 4. Qualitative comparison of scene-level 3D surface reconstruction on the Synthetic Rooms dataset. Credit: *arXiv* (2024). DOI: 10.48550/arxiv.2403.05005

First author of the paper Jaehyeok Shim added, "This technology offers a new way to express 3D data, which holds significant potential for technological development. Collaboration with various academia and industries will play a crucial role in driving this technological advancement."

The research findings will be presented on June 21 at CVPR 2024, a global computer vision conference scheduled to take place from June 17 to 21 in Seattle, U.S.A. The paper is posted to the *arXiv* preprint server.

The research team anticipates that the improved accuracy of DITTO technology could lead to cost savings and increased efficiency in industries such as construction, architecture, and manufacturing.

More information: Jaehyeok Shim et al, DITTO: Dual and Integrated Latent Topologies for Implicit 3D Reconstruction, *arXiv* (2024). [DOI: 10.48550/arxiv.2403.05005](https://doi.org/10.48550/arxiv.2403.05005)

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