ETH zürich | CVL Computer Vision Lab

CVPR JUNE 17-21, 2024 SEATTLE, WA

UniDepth: Universal Monocular Metric Depth Estimation

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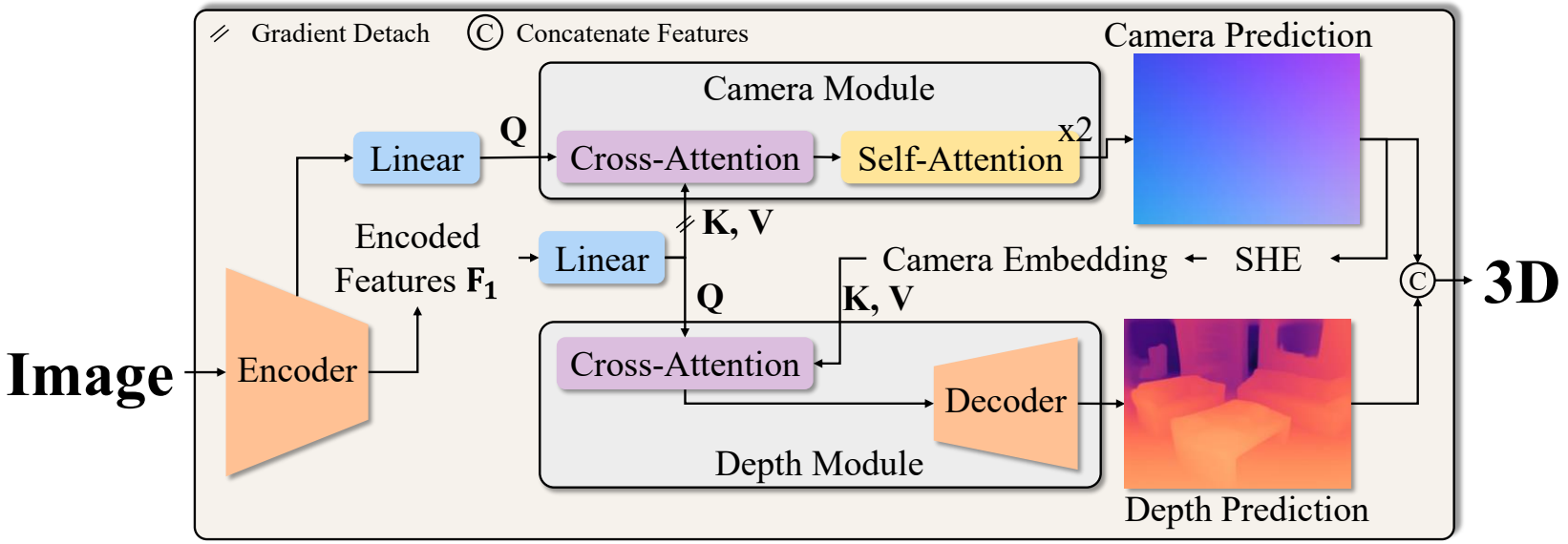
Poster THU-AM-043

Project page: lpiccinelli-eth.github.io/pub/unidepth

Code and models: github.com/lpiccinelli-eth/unidepth

Overview UniDepth

- Prior-free assumption.
- 3D reconstruction from a single image.
- Spherical-representation and camera-bootstrapping for scalability.



Monocular limitation

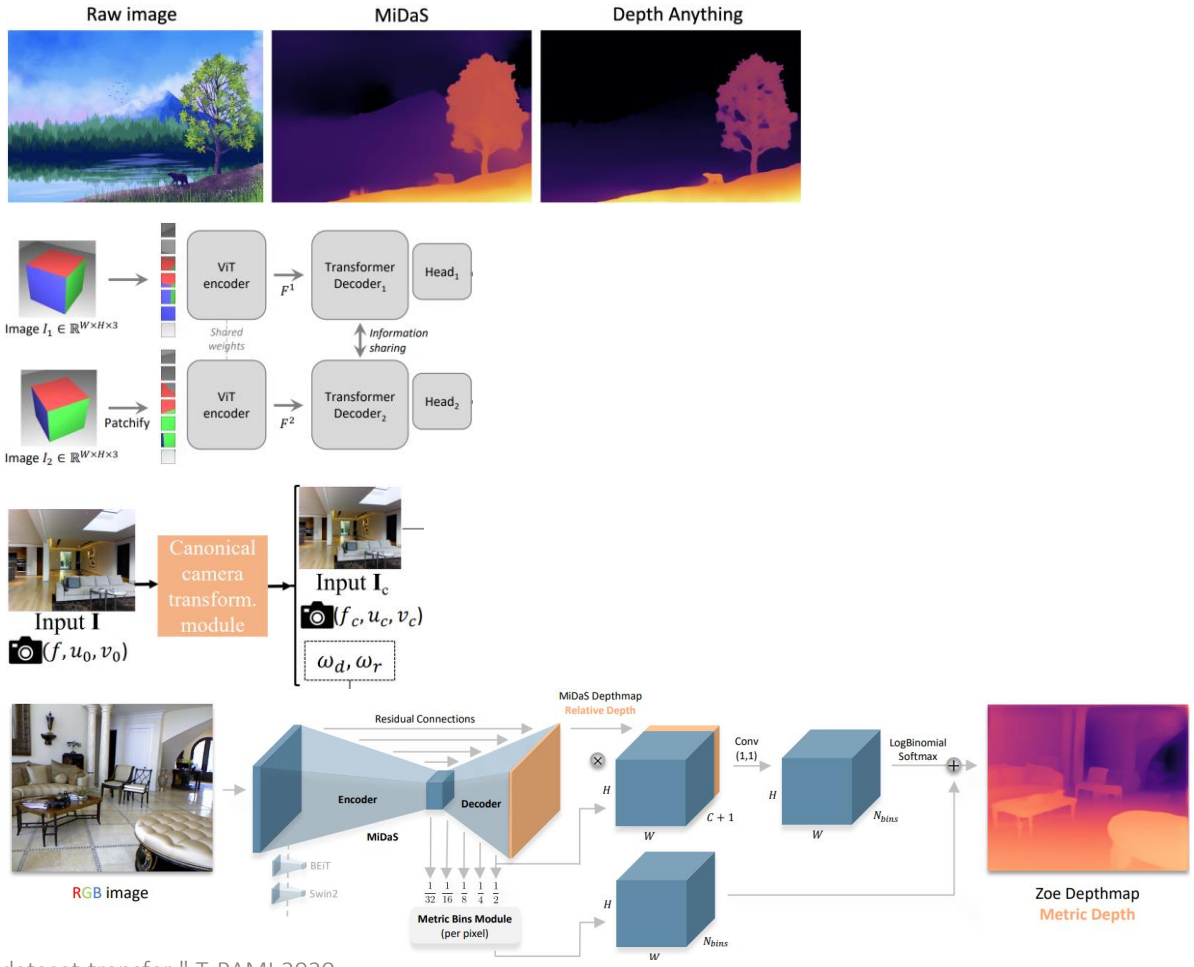
Ill-posed problem: lack of generalization.

- Appearance
- Geometric

Piccinelli, Luigi, et al. "iDisc: internal discretization for monocular depth estimation." CVPR 2023
Yin, Wei, et al. "Metric3D: Towards zero-shot metric 3d prediction from a single image." ICCV 2023

Ambiguity solutions

1. Non-metric [1,2]
2. Multi-view [3]
3. Camera-abstraction [4]
4. Pre-training based [5]



[1] Ranftl, René, et al. "Towards robust monocular depth estimation: Mixing datasets for zero-shot cross-dataset transfer." T-PAMI 2020
[2] Yang, Lihe, et al. "Depth anything: Unleashing the power of large-scale unlabeled data." CVPR 2024.
[3] Wang, Shuzhe, et al. "DUSt3R: Geometric 3D Vision Made Easy." CVPR 2024.
[4] Yin, Wei, et al. "Metric3D: Towards zero-shot metric 3d prediction from a single image." ICCV 2023
[5] Bhat, Shariq Farooq, et al. "ZoEDepth: Zero-shot transfer by combining relative and metric depth." arXiv 2023

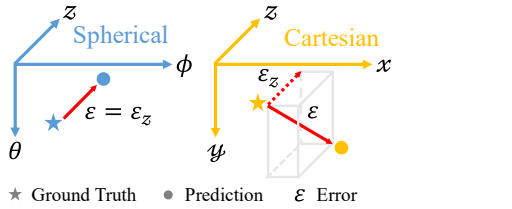
Our approach

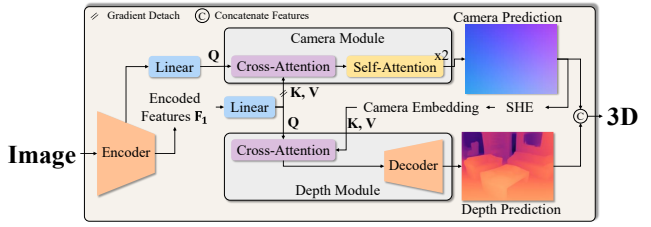
Direct regression in 3D limiting ambiguity

1. Pseudo-Spherical representation

2. Geometric Invariance

3. Camera Bootstrapping



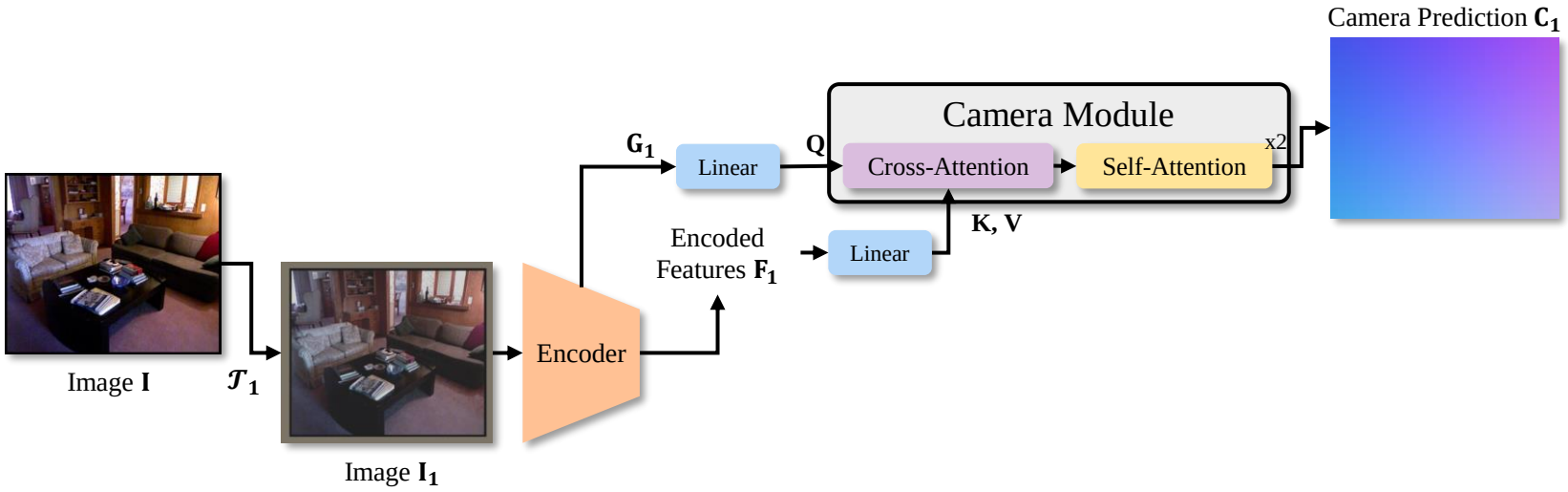


Architecture

Image $\mathbf{I}$ $\mathcal{T}_1$

Image $\mathbf{I_1}$

Architecture



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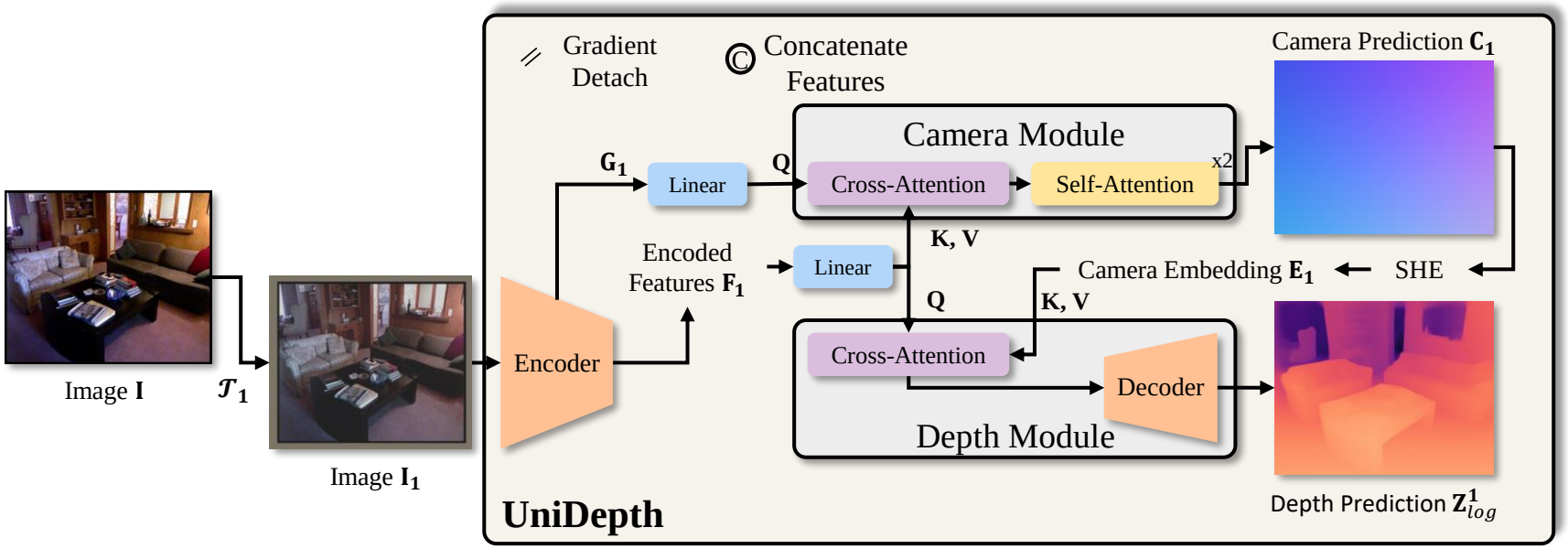

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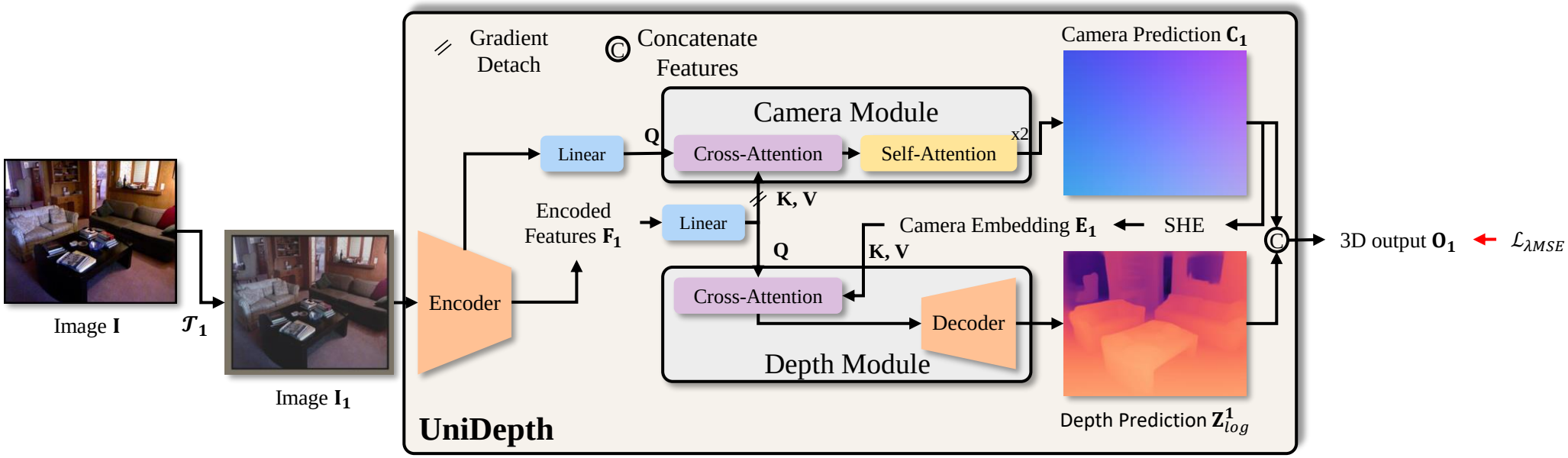

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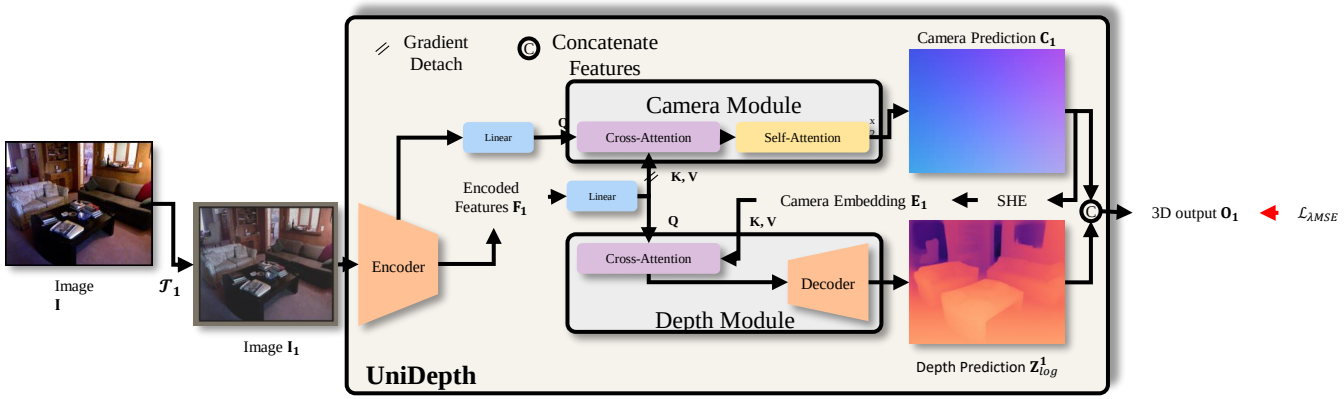

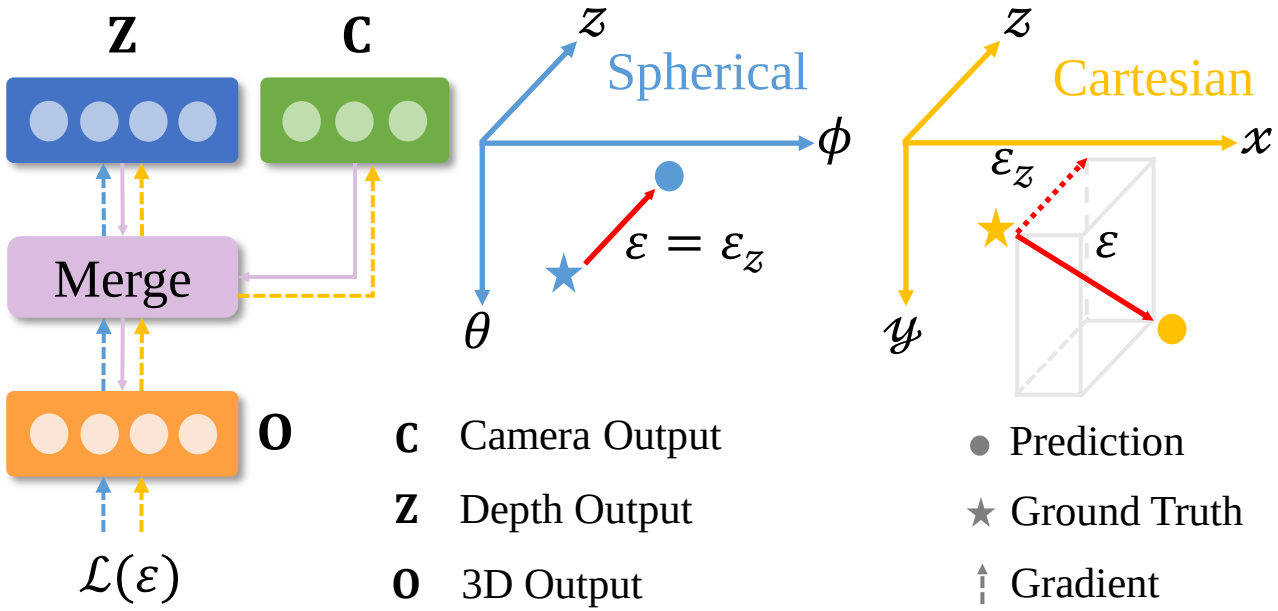

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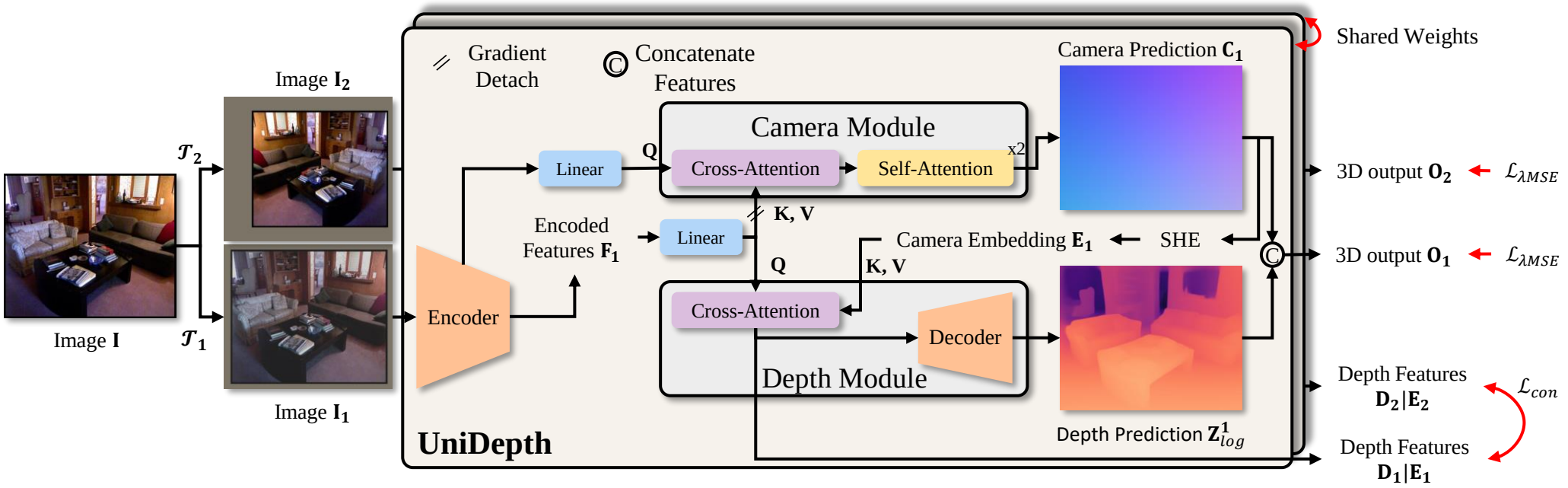
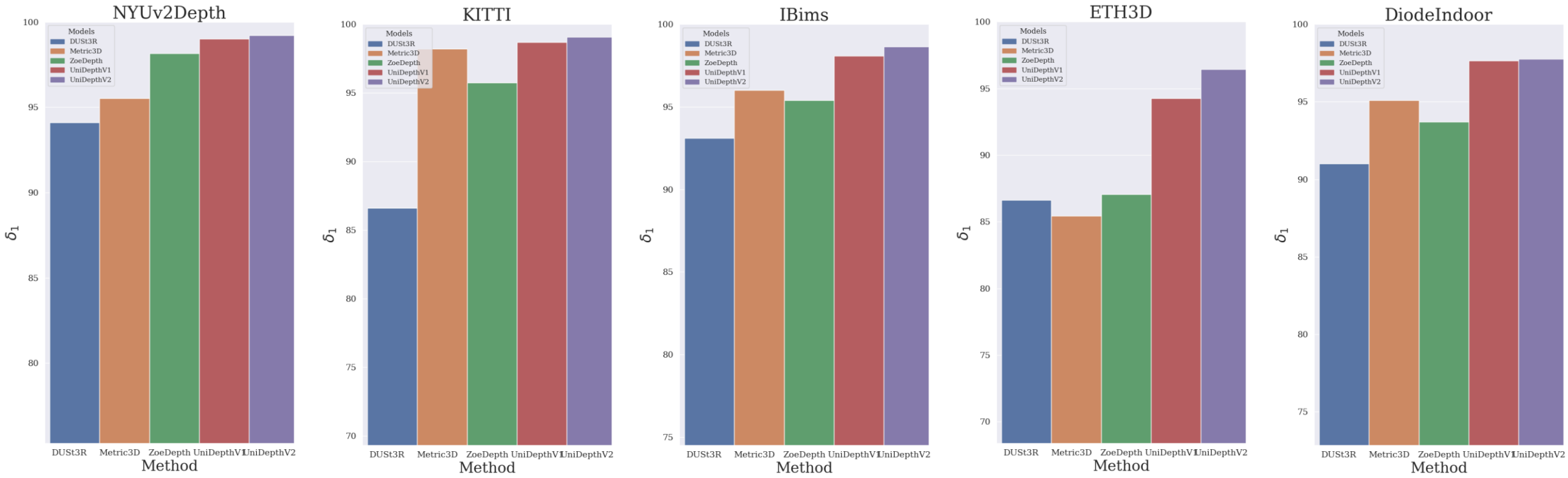


Quantitative results



Metric δ_1 : The higher the better. Depth is GT-rescale for comparison fairness with non-metric methods.

Conclusion

- Data is enough for geometric structure priors
- Metric component fragile to strong domain shifts
- Leveraging temporal consistency can improve ambiguities

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