NU-MCC: Multiview Compressive Coding with Neighborhood Decoder and Repulsive UDF

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NU-MCC: Multiview Compressive Coding with Neighborhood Decoder and Repulsive UDF

Input

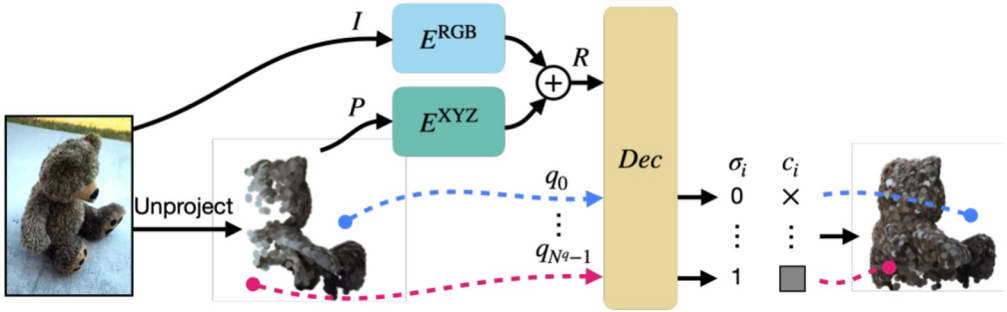
Single-View RGB-D Image

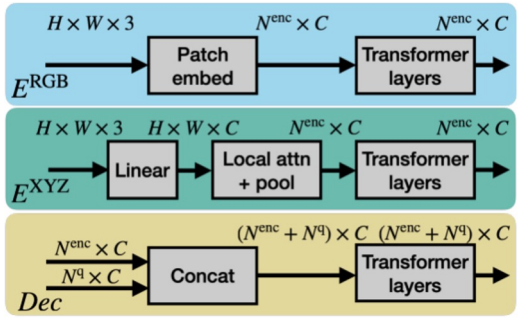
NU-MCC

Output

Complete 3D object

Multiview Compressive Coding for 3D Reconstruction (MCC)





Drawback:

- Slow inference speed
- Coarse reconstruction

Input

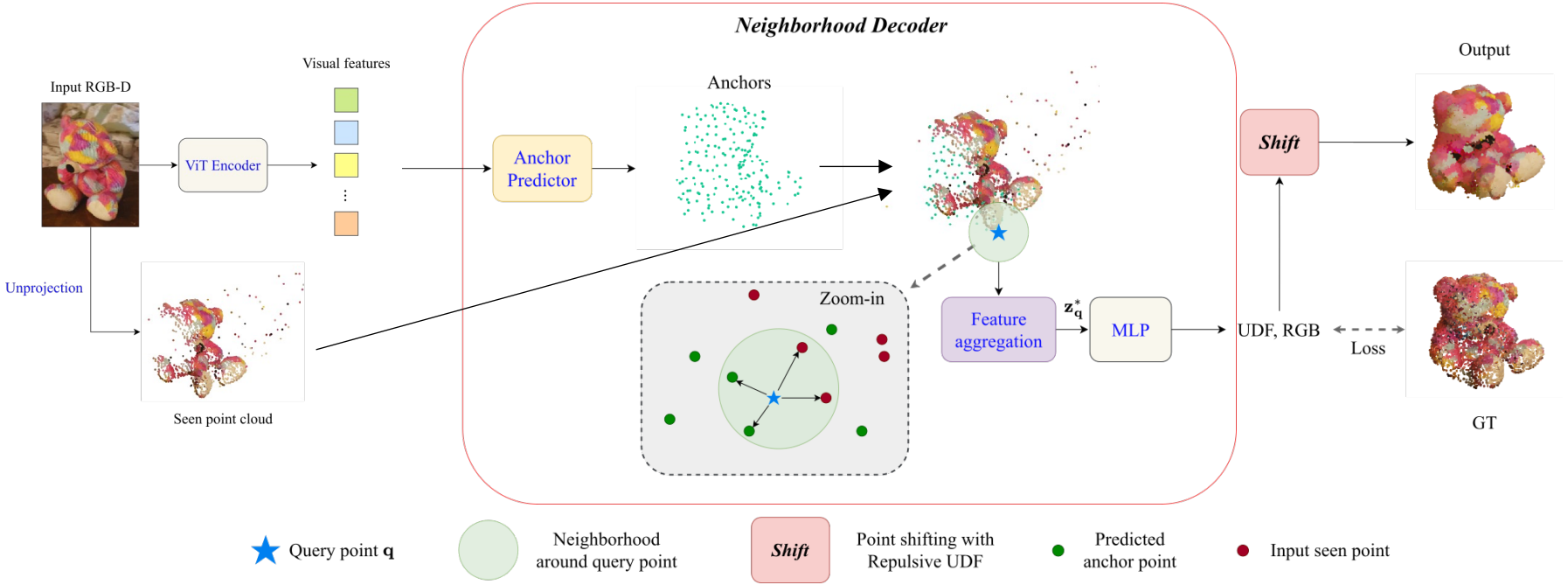
>18s

MCC

Output

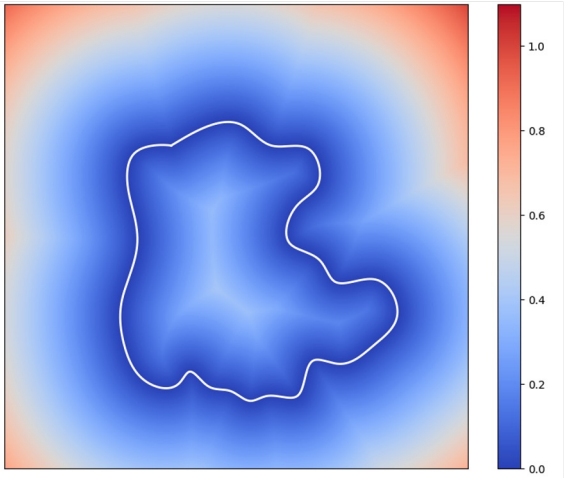
Wu et al. Multiview Compressive Coding for 3D Reconstruction. CVPR, 2023.

Neighborhood decoder



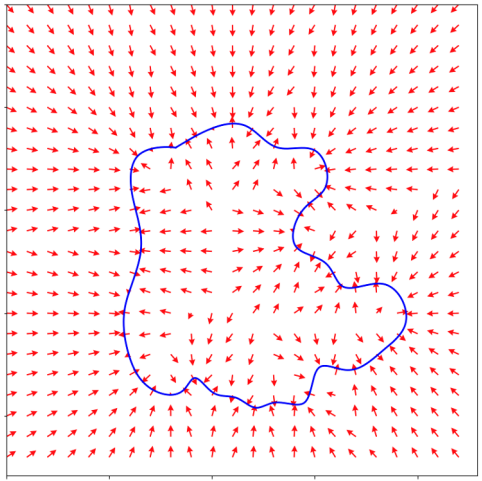
Standard Unsigned Distance Function (UDF)

UDF $f(\mathbf{q})$



$\mathbf{q}$ = sampled 3D location

$$-\frac{\nabla_{\mathbf{q}} f(\mathbf{q})}{\|\nabla_{\mathbf{q}} f(\mathbf{q})\|}$$

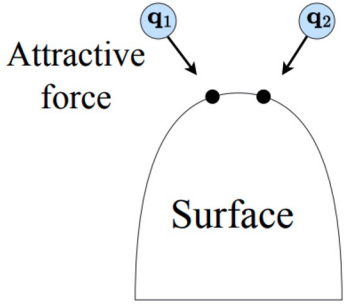


Dense points on the surface can be obtained by point-shifting:

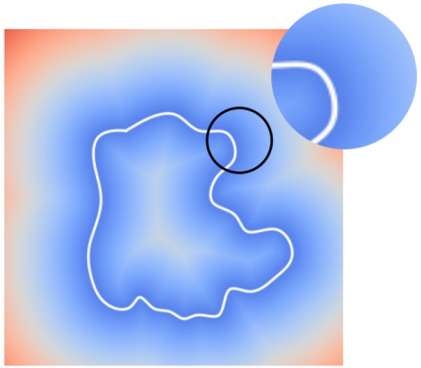
$$\mathbf{q} \leftarrow \mathbf{q} - f(\mathbf{q}) \cdot \frac{\nabla_{\mathbf{q}} f(\mathbf{q})}{\|\nabla_{\mathbf{q}} f(\mathbf{q})\|}$$

Chibane et al. Neural Unsigned Distance Fields for Implicit Function Learning. NeurIPS, 2020.

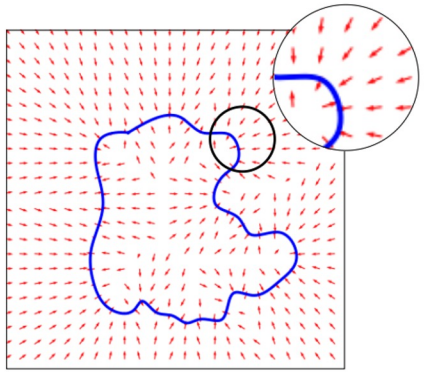
Standard Unsigned Distance Function (UDF)



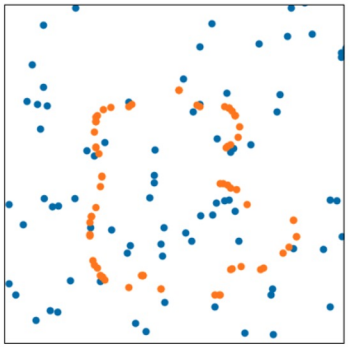
(a) Force analysis



(b) Potential field



(c) Motion field



(d) Point shifting result

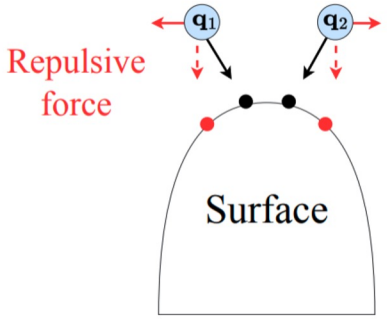
$$\mathbf{q} \leftarrow \mathbf{q} - f(\mathbf{q}) \cdot \frac{\nabla_{\mathbf{q}} f(\mathbf{q})}{\|\nabla_{\mathbf{q}} f(\mathbf{q})\|}$$

Favor high-curvature regions

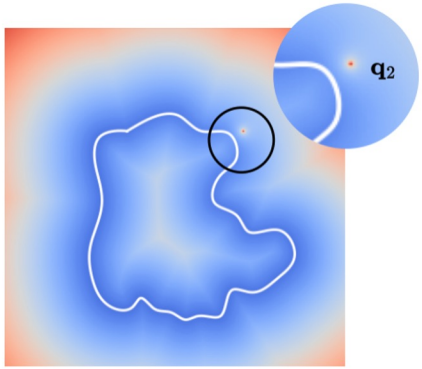
Holes artifacts

☹

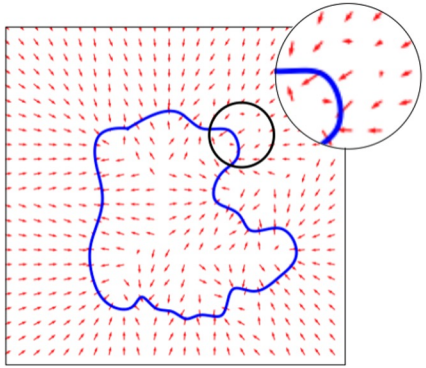
Repulsive UDF



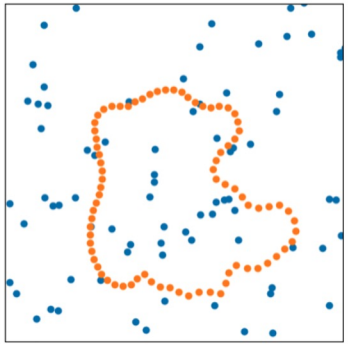
(a) Force analysis



(b) Potential field



(c) Motion field



(d) Point shifting result

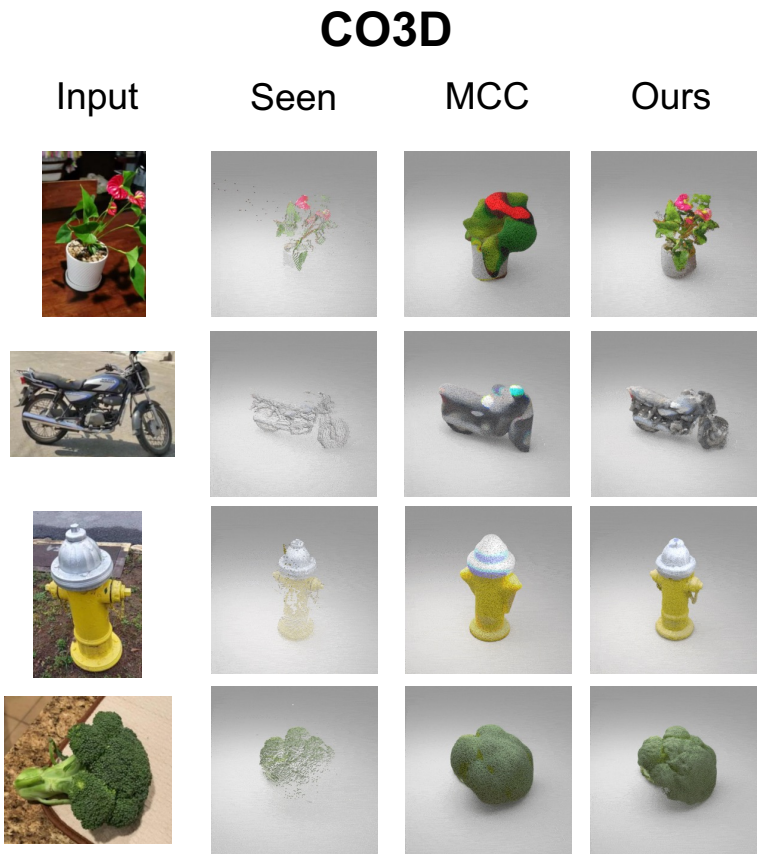
$$\mathbf{q} \leftarrow \mathbf{q} - f(\mathbf{q}) \cdot \frac{\nabla_{\mathbf{q}} f(\mathbf{q})}{\|\nabla_{\mathbf{q}} f(\mathbf{q})\|} + \sum_{i \in \mathcal{N}_{\mathbf{q}}} \frac{\mathbf{q} - \mathbf{q}_i}{\|\mathbf{q} - \mathbf{q}_i\|^2}$$

Repulsive force from the nearest points of $\mathbf{q}$

Uniform points on the surface

☺

Results

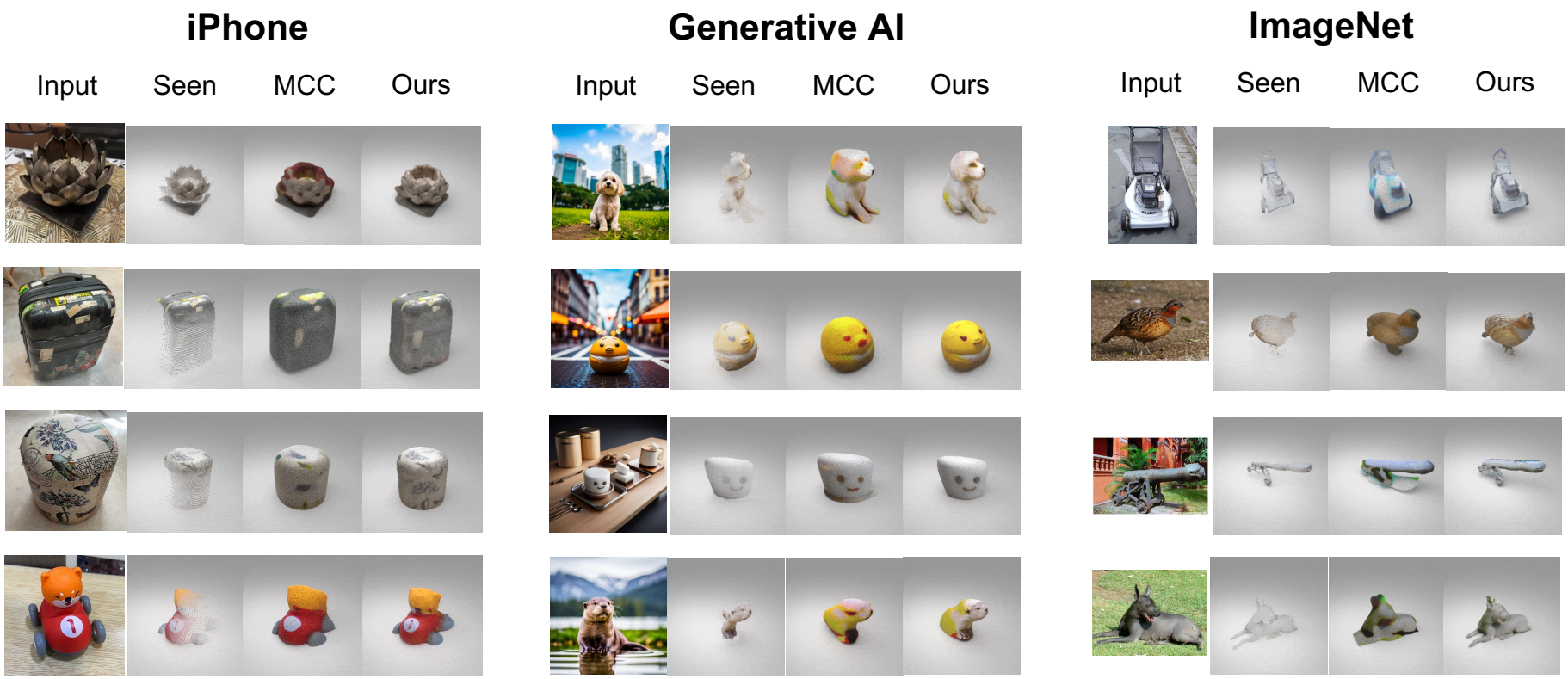


Architecture	Representation	L_1-CD↓	F1↑	L_1-RGB↓	Runtime (s)↓
MCC [4]	Occ	0.284	76.4[1]	0.376	18.5
Ours (no fine)	Occ	0.292	76.8	0.374	**1.2**
Ours	Occ	0.282	79.0	0.340	1.5
Ours	UDF	0.264	78.2	**0.316**	3.2
	RepUDF	**0.237**	**83.8**	0.320	3.5

Table 1: **Quantitative results on CO3D-v2 [5] validation set.** Results are obtained using 216k query points and averaged over three different views.

9.7% F1-score improvement
>5x faster inference

Results: Zero-shot generalization



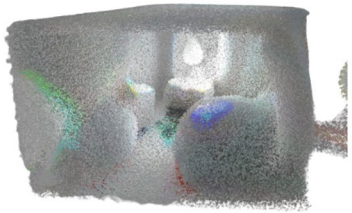
Results: Scene

Photorealistic Synthetic Dataset (Hypersim)

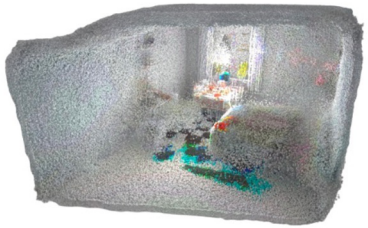
IMAGE

SEEN

MCC



OURS



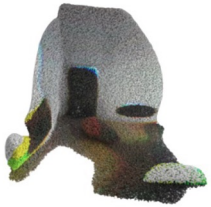
Zero-Shot

Real Dataset (Taskonomy)

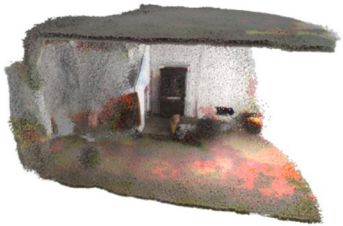
IMAGE

SEEN

MCC



OURS



Thank you!

Project page : https://numcc.github.io
Code: https://github.com/sail-sg/numcc

Project page

Code