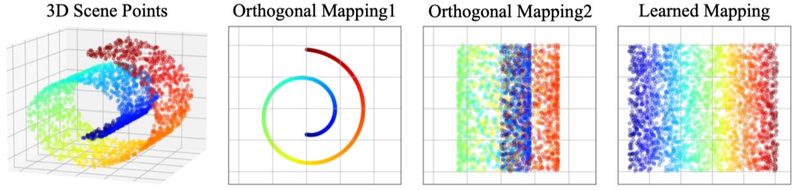
General Neural Gauge Fields

Fangneng Zhan, Lingjie Liu, Adam Kortylewski, Christian Theobalt*
Max Planck Institute for Informatic, Germany
* Indicates corresponding author

MAX PLANCK GESELLSCHAFT

ICLR

Motivation:

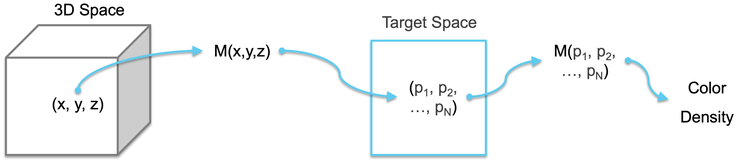


Existing works:

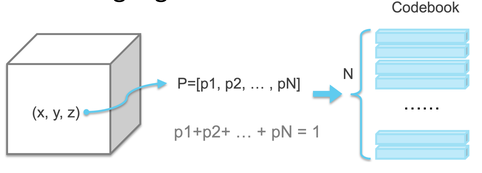
Methods	Space	Gauge Transformation
EG3D	3D to 2D	orthogonal projection (pre-defined)
TensoRF	3D to hybrid 1D &2D	orthogonal projection (pre-defined)
Instant-NGP	3D to 1D	spatial hash function (pre-defined)

Learning Gauge Transformation:

Continuous gauge transformation:



Discrete gauge transformation:

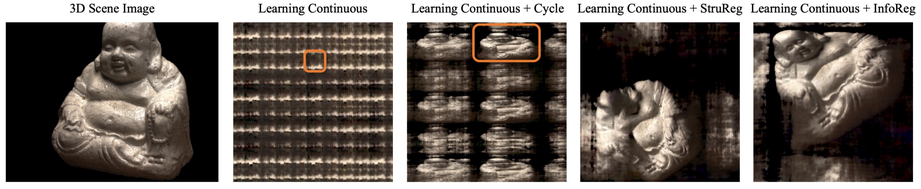


Algorithm 1 Pseudo code of forward & backward propagation in learning discrete gauge transformation.

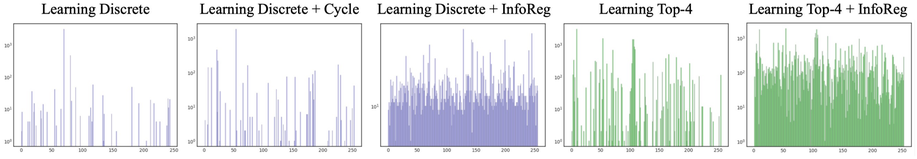
Input: A 3D point x, predicted distribution $P_x = [p_1, p_2, \cdots, p_N]$, codebook $\mathcal{V}$.
Forward propagation:
1. index = Argmax(P_x)
2. index_hard = One_Hot(index)
3. feature lookup: v_x = Matmul(index_hard, $\mathcal{V}$)
Backward propagation:
1. index_soft = Softmax(P_x)
2. feature lookup: v_x = Matmul(index_soft, $\mathcal{V}$)
Output: feature v_x.

Learning Collapse:

Continuous case:



Discrete case:



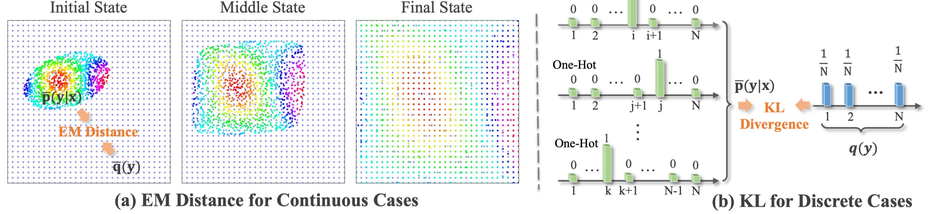
InfoReg for Regularization:

Information conservation during transformation:

$$I(X,Y) = \iint p(x,y)\log\frac{p(x,y)}{p(x)p(y)}dxdy = \iint p(y|x)p(x)\log\frac{p(y|x)}{p(y)}dxdy$$

$$\mathcal{L}_{reg} = \min_{p(y|x)}\left\{-(\gamma+\epsilon)\cdot\mathbb{E}[KL(p(y|x)p(x)||p(y)p(x))] + \epsilon\cdot\mathbb{E}[KL(p(y|x)||q(y))]\right\}$$

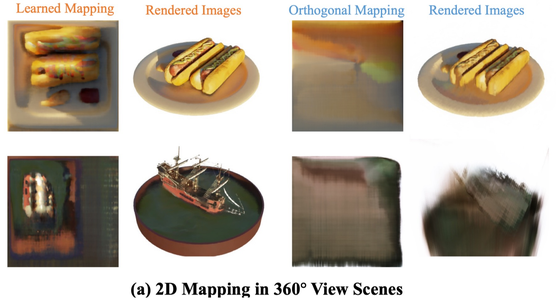
Prior distribution term:



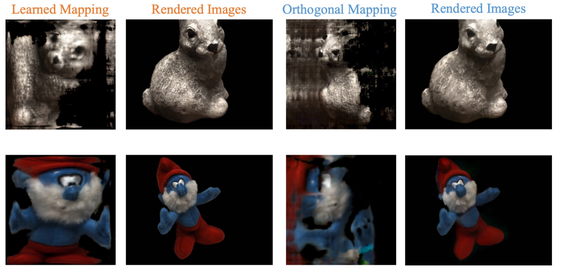
(a) EM Distance for Continuous Cases

(b) KL for Discrete Cases

Results:



(a) 2D Mapping in 360° View Scenes



(b) 2D Mapping in Limited View Scenes