Depth Coefficients for Depth Completion

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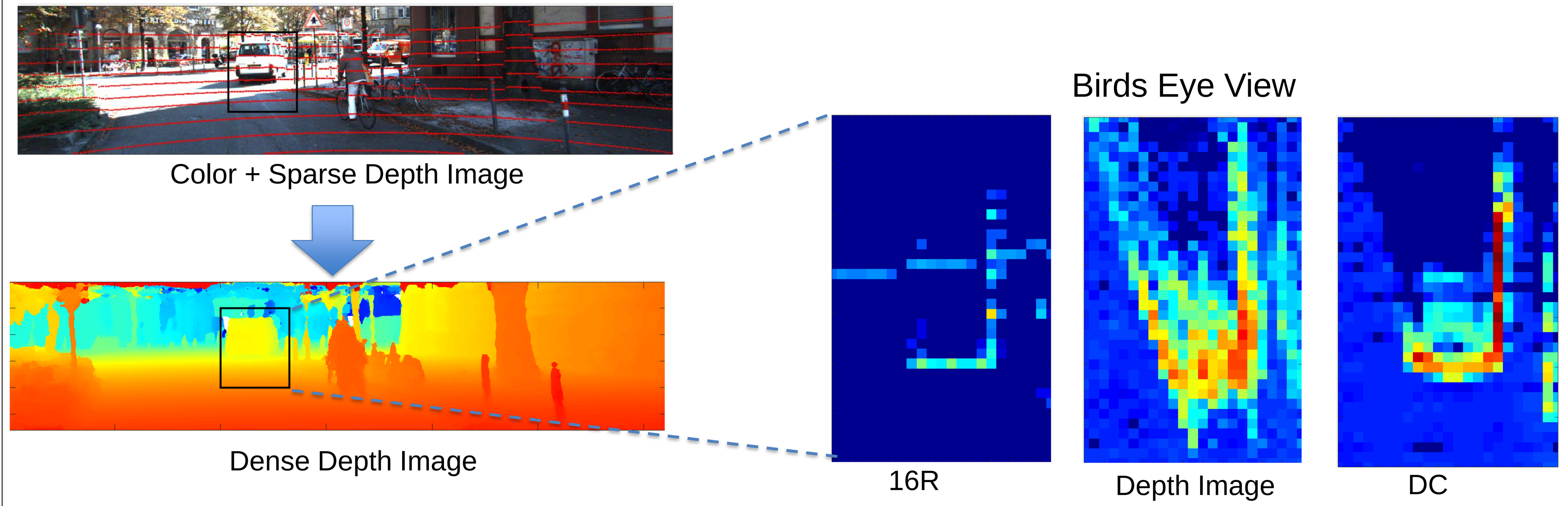
Problem Statement

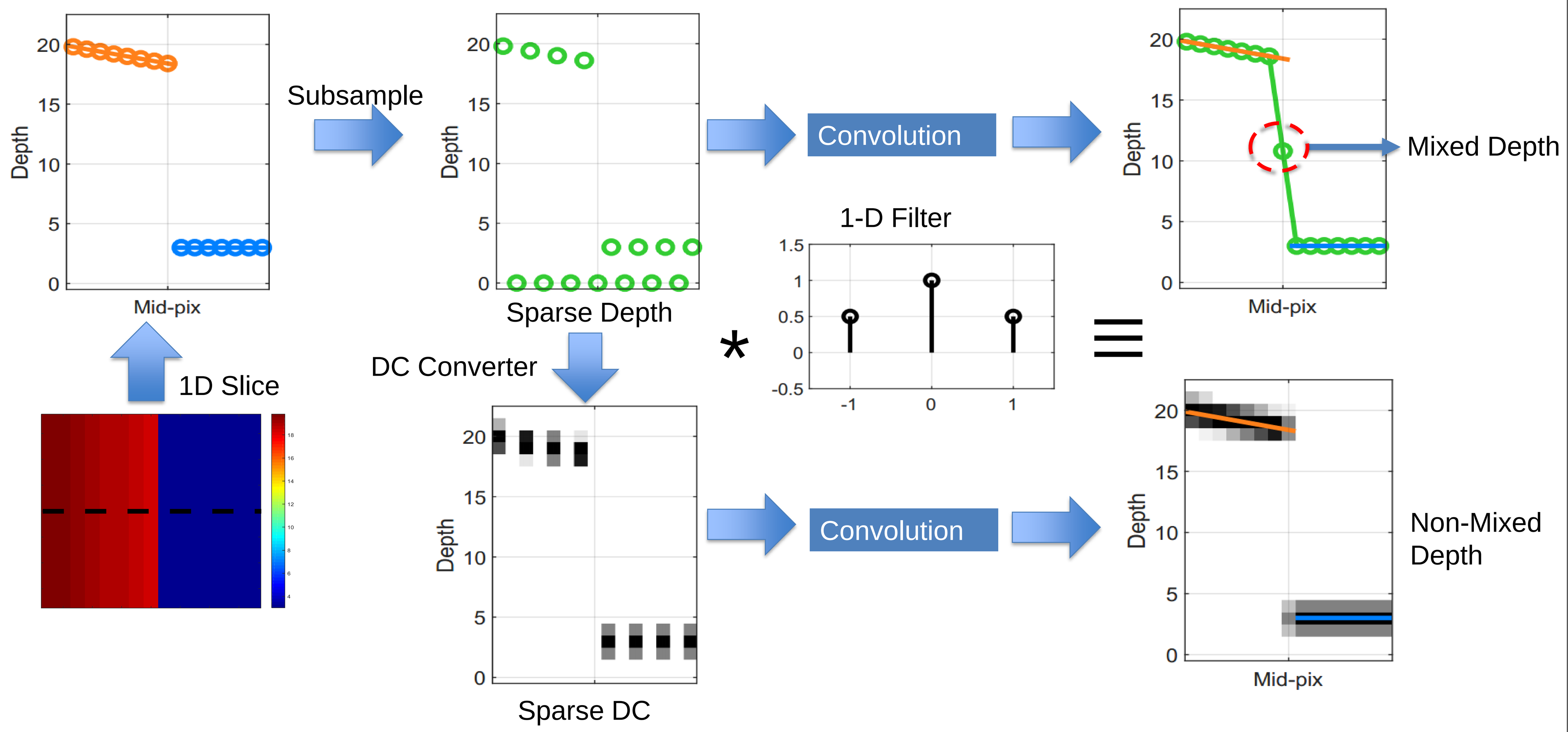
- Given sparse depth and color image can we estimate **dense** depth, **without smearing depth,** across object **boundaries**?

Contributions:

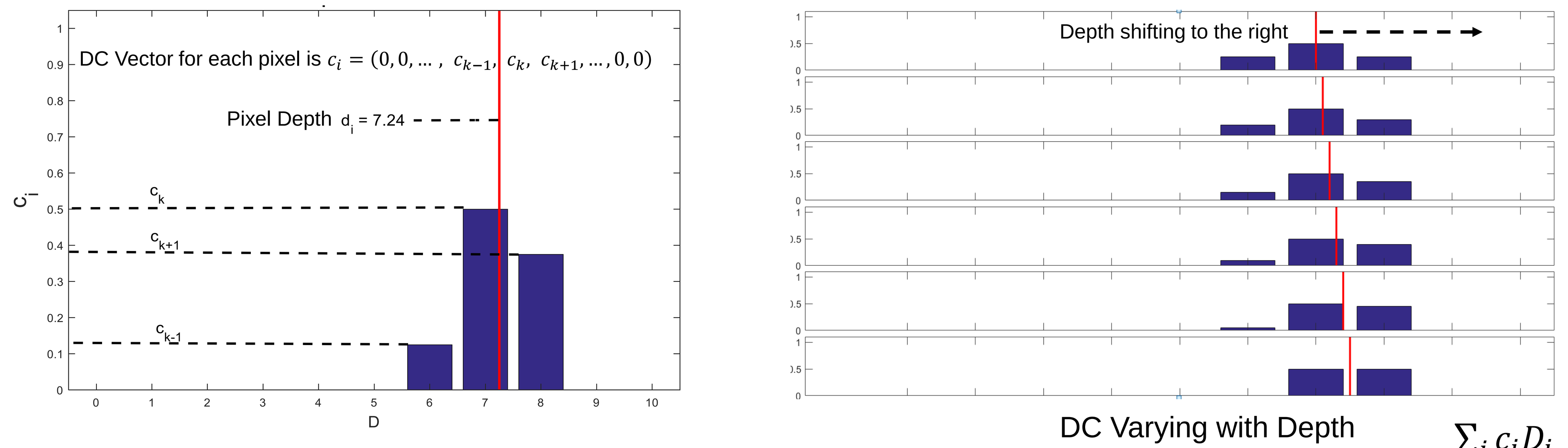
- New depth representation (depth coefficients) that prevent smearing across boundaries.
- Learning by Cross-Entropy Loss.
- Improved object detection performance from super-resolved depth.



Motivation by Convolution



Depth Coefficients (DC): Representation of Depth



Depth can be recovered **exactly** by using the DC weights of each binned depth by, $d_i = \frac{\sum_i c_i D_i}{\sum_i c_i}$

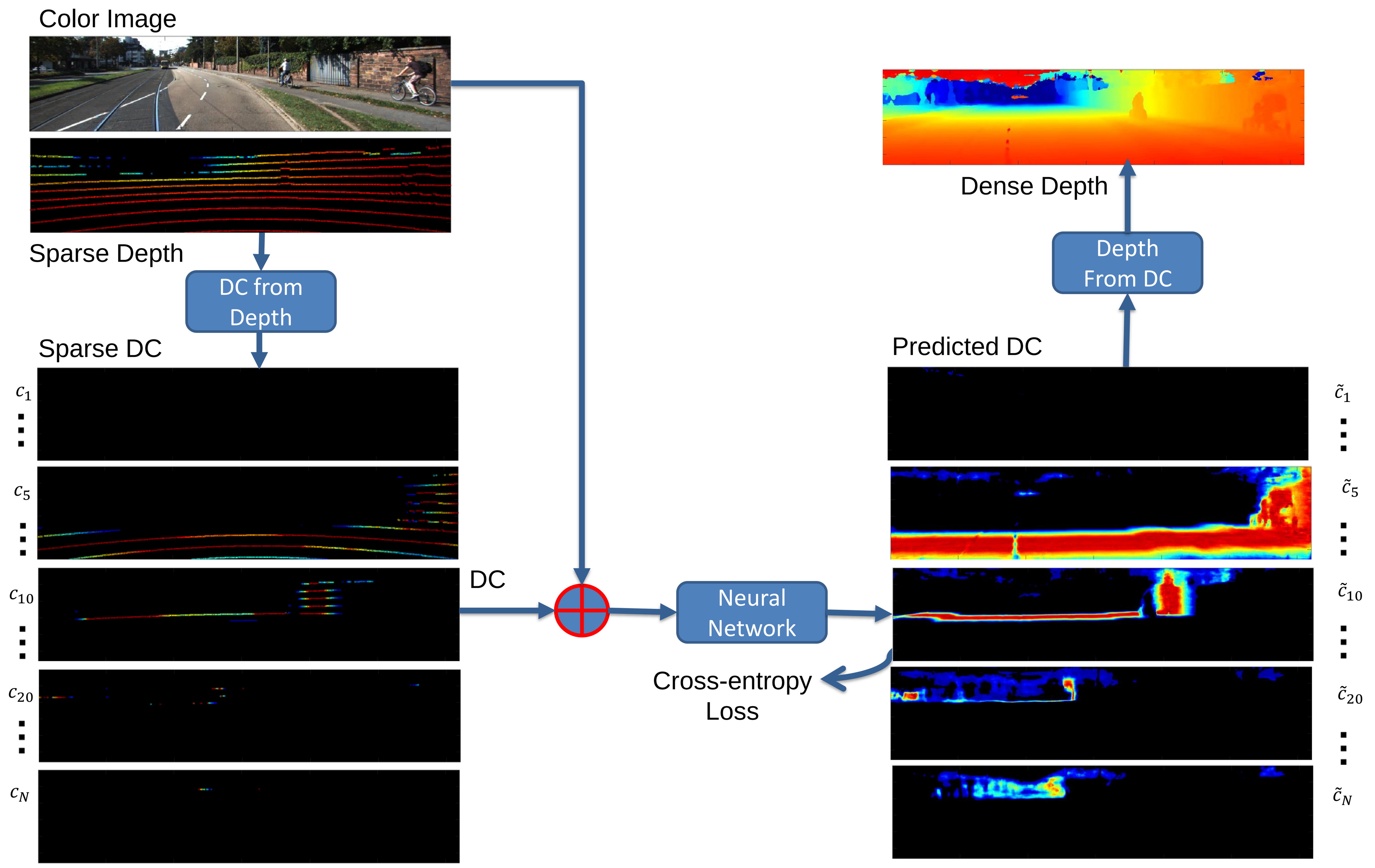
Loss Function

We use the **Cross-entropy** loss as opposed to **MSE** or **MAE**

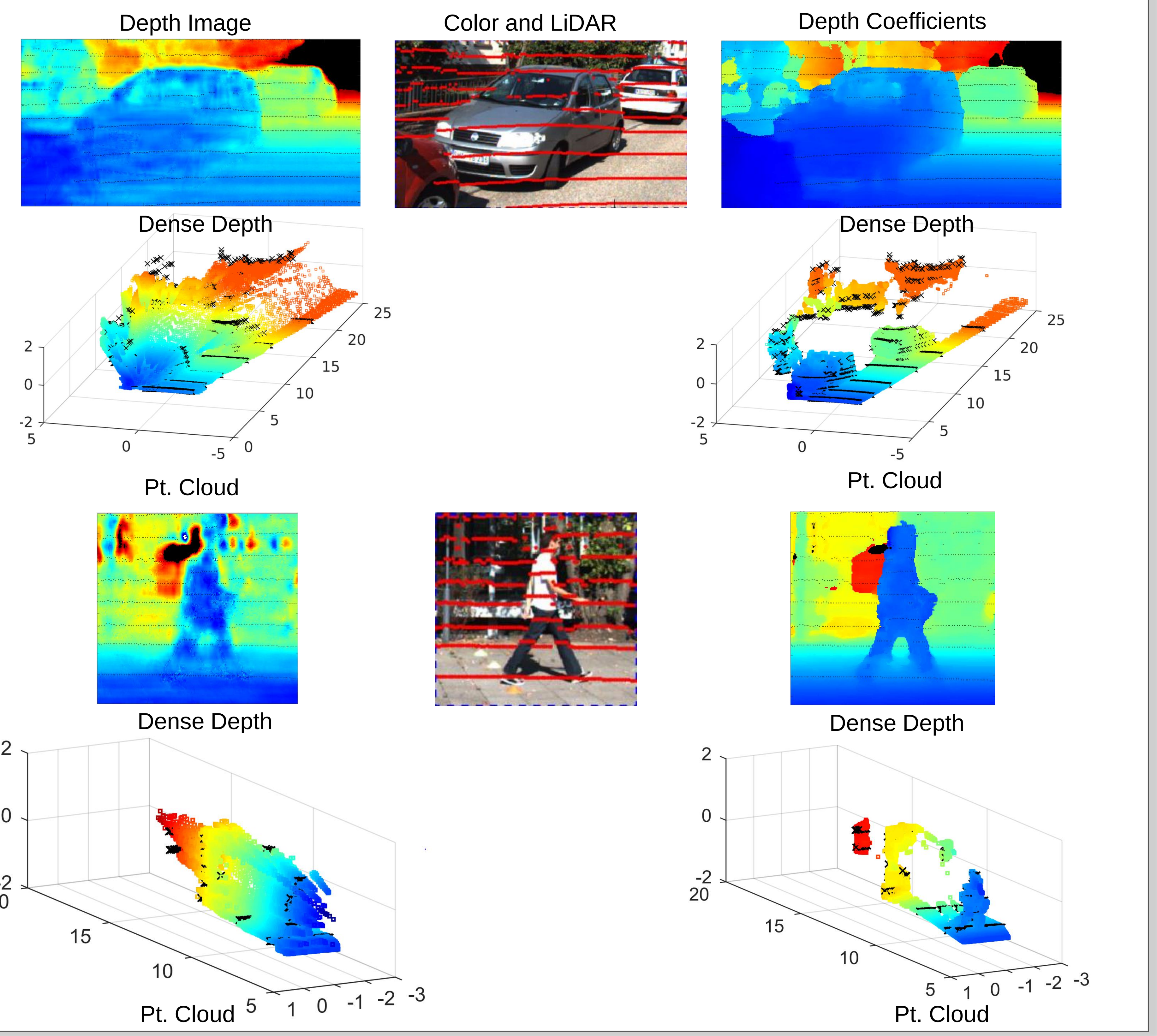
$$L_i^{ce}(c_{ij}) = -\sum_{j=1}^{N} c_{ij}\log(\hat{c}_{ij})$$

N: Total no. of pixels.
i: ith binned depth

Using DC with a Neural Network



Sample Results



Quantitative Results

Meth.	MAE	RMSE
DI [1]	65.2	174.3
DC	**37.8**	**160.6**

Table 1. KITTI Validation Bechmark with 16R LiDAR Scans.

Units are in cm
DI: Depth Image
DC: Depth Coefficients

Input	Loss	MAE	RMSE
DI [1]	MSE	6.63	15.28
DC	MSE	6.10	15.32
DI [1]	CE	9.53	17.81
DC	CE	**3.82**	**11.85**

Table 2. NYU2 Test Benchmark with Uniform-500 Samples.

Upsamp	3D Bounding Box			Bird's Eye View Box		
	Easy	Med.	Hard	Easy	Med.	Hard
16R	54.4	36.2	31.3	73.6	**58.1**	**50.4**
DI[1]	36.7	23.0	18.5	56.2	33.8	29.7
DC	**64.9**	**41.9**	**34.7**	**78.1**	54.0	45.6

Table 3. Object Detection Results based on Frustum Point-Net [2].

For Source code on github, visit https://github.com/imransai/Depth-Coefficients-4-DepthCompletion please use Qrcode:

[1]. Ma, Fangchang, Guilherme Venturelli Cavalheiro, and Sertac Karaman. "Self-supervised sparse-to-dense: self-supervised depth completion from lidar and monocular camera." *arXiv preprint arXiv:1807.00275* (2018).
[2]. Qi, Charles R., et al. "Frustum pointnets for 3d object detection from rgb-d data." *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition*. 2018.