Deep Outdoor Illumination Estimation

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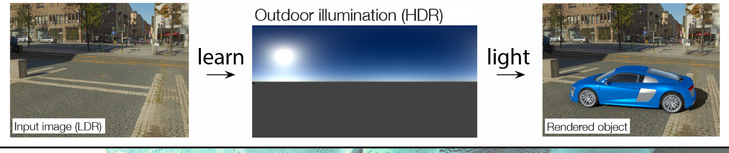
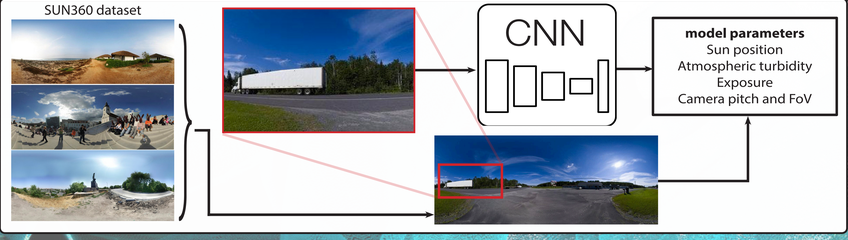
Motivation

Goal: Estimate high dynamic range lighting conditions and camera parameters from a single outdoor low dynamic range image.



Dataset preparation



CNN achitecture and training

CNN architecture

Layer	Stride	Resolution
Input		320×240
conv7-64	2	160×120
conv5-128	2	80×60
conv3-256	2	40×30
conv3-256	1	40×30
conv3-256	2	20×15
conv3-256	1	20×15
conv3-256	2	10×8
FC-2048		
FC-160 LogSoftMax		FC-5 Linear
Output: sun position distribution $\mathbf{s}$		Output: sky and camera parameters $\mathbf{q}$

The ELU activation function and batch normalization are used at every layer.

Training using stochastic gradient descent with Adam with an initial learning rate of 0.01.

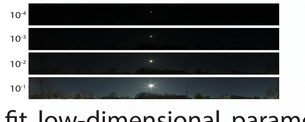
7 crops were taken for each of the 38,814 panoramas of SUN360 and then split into (261,288 / 1,751 / 8,659) subsets for (train / validation / test). Extra care was taken to ensure no panorama overlap between those subsets.

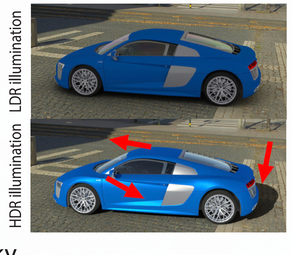
For more

jflalonde.ca/projects/deepOutdoorLight/

Problems and solution

High Dynamic Range 360° panoramas properly capture omnidirectional lighting. Unfortunately, no such dataset currently exists to train a deep neural network.

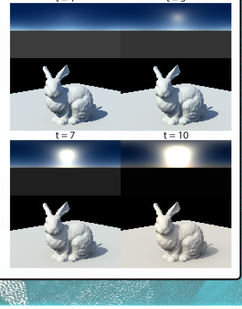




Solution: fit low-dimensional parametric sky model (Hošek-Wilkie) on the SUN360 dataset.

$$f_h^c(\mathbf{l};\mathbf{q}_h) = \omega\left[f_{sun}^c(\mathbf{l}_{\text{sun}},t) + f_{sky}^c(\mathbf{l}_{\text{sun}},t)\right]$$

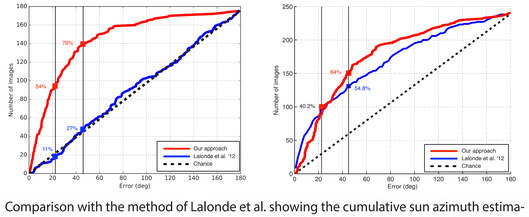
Impact of the turbidity (t) on sky appearance and renders



Results

Sun position estimation

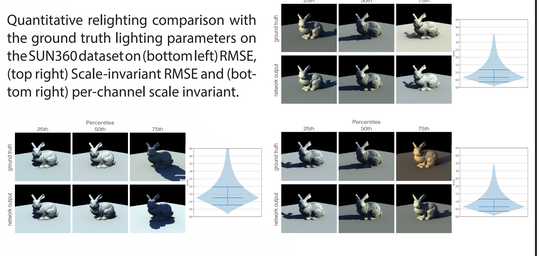
Quantitative performance



Comparison with the method of Lalonde et al. showing the cumulative sun azimuth estimation error on (a) a 176-image subset from the SUN360 test set, and (b) their original dataset.

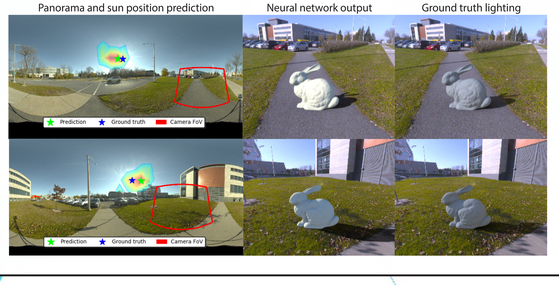
Relighting on SUN360

Quantitative relighting comparison with the ground truth lighting parameters on the SUN360 dataset on (bottom left) RMSE, (top right) Scale-invariant RMSE and (bottom right) per-channel scale invariant.



Virtual object insertion

Virtual object insertion on HDR validation set



Camera elevation and field of view estimation