Deep Specialized Network for Illuminant Estimation

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Introduction

Challenges

- The observed color I is given by

$$I_c = E_c \times R_c, \qquad c \in \{r, g, b\} \qquad (1)$$

where E is the illumination and R is the reflectance. Estimating E from I is under-determined.

- Searching the large hypothesis space for an accurate illuminant estimation is hard due to the ambiguities of unknown reflections and local patch appearances.

Contributions

- The proposed network combines two networks to work hand-in-hand for robust illuminant estimation.
- A novel notion of 'branch-level ensemble' is introduced.
- Through a winner-take-all learning scheme, the two branches of HypNet are encouraged to specialize on estimating illuminants for specific regions.
- SelNet yields much better final predictions than simply averaging the hypotheses.

Methods

The proposed Deep Specialized Network consists of two closely coupled sub-networks:

(1) *HypNet*

- Generates two competing hypotheses for an illuminant estimation of an image patch.
- The 'winner-take-all' learning strategy

$$L(\Theta) = \min_{k \in \{A,B\}} (\|\tilde{\mathbf{E}}_k - \mathbf{E}^*\|_2^2) \qquad (2)$$

where $\tilde{\mathbf{E}}_k$ is the estimate of branch k and $\mathbf{E}^*$ is the ground truth illumination.

(2) *SelNet*

- Generates a score vector to pick the final illuminant estimation from one of the branches in HypNet.
- During training, the ground truth label for SelNet is generated from the ground truth illumination and the two hypotheses obtained from HypNet.

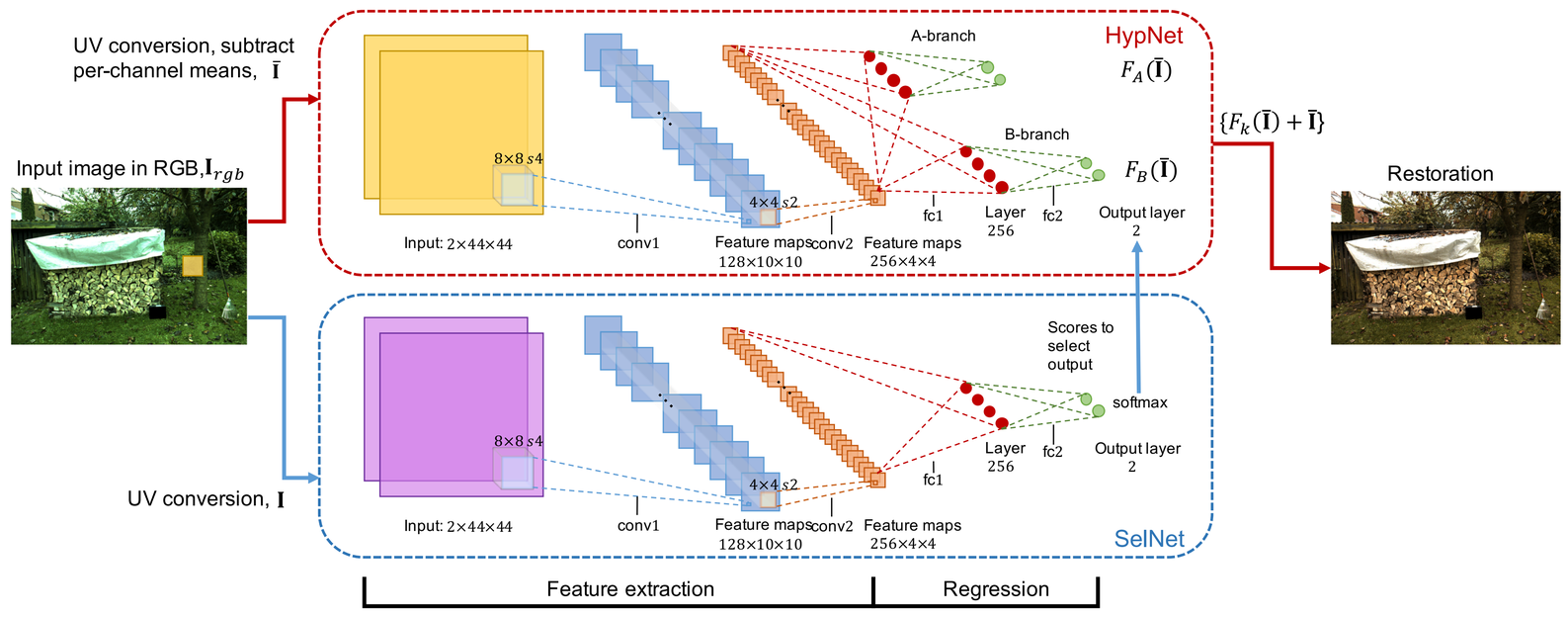
References

[1] Peter Vincent Gehler, Carsten Rother, Andrew Blake, Tom Minka, and Toby Sharp. Bayesian color constancy revisited. pages 1–8, 2008.

[2] L. Shi and B. Funt. Re-processed version of the gehler color constancy dataset of 568 images. accessed from `http://www.cs.sfu.ca/~colour/data/`.

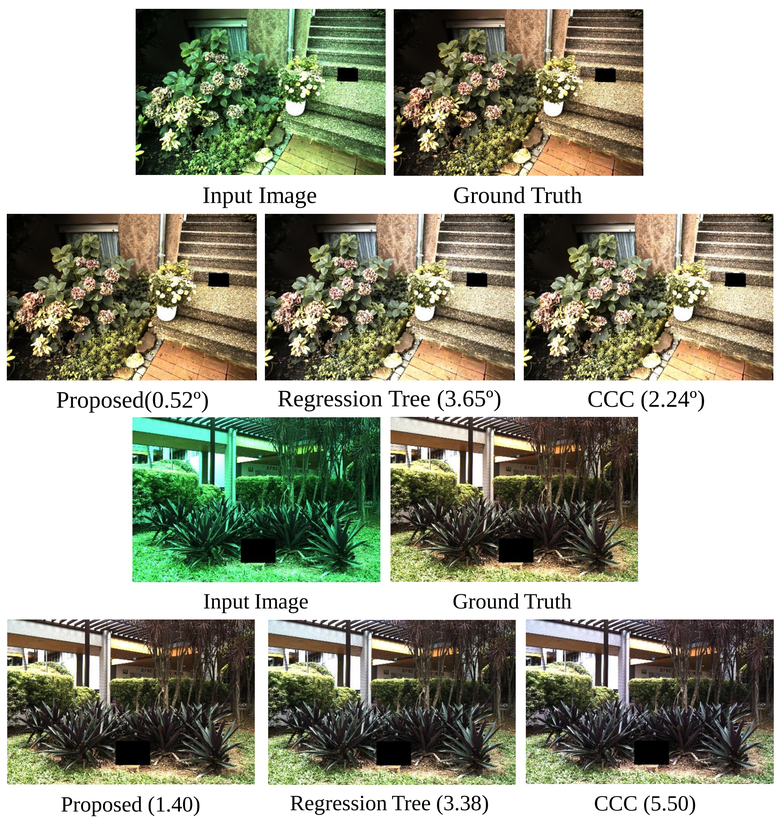
[3] Dongliang Cheng, Dilip K Prasad, and Michael S Brown. Illuminant estimation for color constancy: why spatial-domain methods work and the role of the color distribution. 31(5):1049–1058, 2014.

Methods (Network)



Experimental Results

Global-Illuminant Setting



Methods	Mean	Median	Trimean
White-Patch	7.55	5.68	6.35
Edge-based Gamut	6.52	5.04	5.43
Gray-World	6.36	6.28	6.28
1st-order Gray-Edge	5.33	4.52	4.73
2nd-order Gray-Edge	5.13	4.44	4.62
Shades-of-Gray	4.93	4.01	4.23
Bayesian	4.82	3.46	3.88
General Gray-World	4.66	3.48	3.81
Intersection-based Gamut	4.20	2.39	2.93
Pixel-based Gamut	4.20	2.33	2.91
Natural Image Statistics	4.19	3.13	3.45
Bright Pixels	3.98	2.61	–
Spatio-spectral (GenPrior)	3.59	2.96	3.10
Cheng et al.	3.52	2.14	2.47
Corrected-Moment (19 Color)	3.50	2.60	–
Exemplar-based	3.10	2.30	–
Corrected-Moment (19 Edge)	2.80	2.00	–
CNN	2.36	1.98	–
Regression Tree	2.42	1.65	1.75
CCC (disc+ext)	1.95	1.22	1.38
HypNet One Branch	2.18	1.35	1.54
HypNet (A-branch)	5.06	4.38	4.52
HypNet (B-branch)	4.55	2.35	3.10
DS-Net (Average)	3.74	2.99	3.18
DS-Net (HypNet+SelNet)	**1.90**	**1.12**	**1.33**
DS-Net (HypNet+Oracle)	1.15	0.76	0.86

Table 1: The Color Checker [1, 2] dataset.

Methods	Mean	Median	Trimean
White-Patch	10.62	10.58	10.49
Edge-based Gamut	8.43	7.05	7.37
Pixel-based Gamut	7.70	6.71	6.90
Intersection-based Gamut	7.20	5.96	6.28
Gray-World	4.14	3.20	3.39
Bayesian	3.67	2.73	2.91
Natural Image Statistics	3.71	2.60	2.84
Shades-of-Gray	3.40	2.57	2.73
Spatio-spectral (ML)	3.11	2.49	2.60
General Gray-World	3.21	2.38	2.53
2nd-order Gray-Edge	3.20	2.26	2.44
Bright Pixels	3.17	2.41	2.55
1st-order Gray-Edge	3.20	2.22	2.43
Spatio-spectral (GenPrior)	2.96	2.33	2.47
Cheng et al.	2.92	2.04	2.24
CCC (disc+ext)	2.38	1.48	1.69
Regression Tree	2.36	1.59	1.74
HypNet One Branch	2.56	1.87	2.01
HypNet (A-branch)	3.49	2.94	3.03
HypNet (B-branch)	5.17	2.91	3.50
DS-Net (Average)	3.41	2.36	2.72
DS-Net (HypNet+SelNet)	**2.24**	**1.46**	**1.68**
DS-Net (HypNet+Oracle)	1.32	0.93	1.01

Table 2: The NUS 8-camera [3] dataset.

Experimental Results

HypNet Results

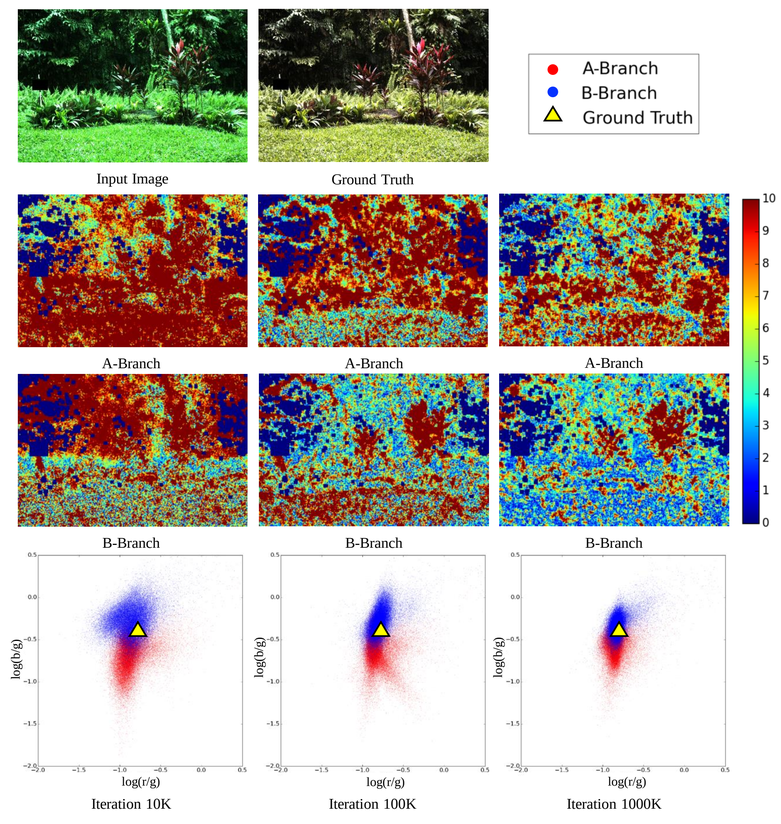


Figure 1: Learning of two branches of HypNet.

SelNet Results

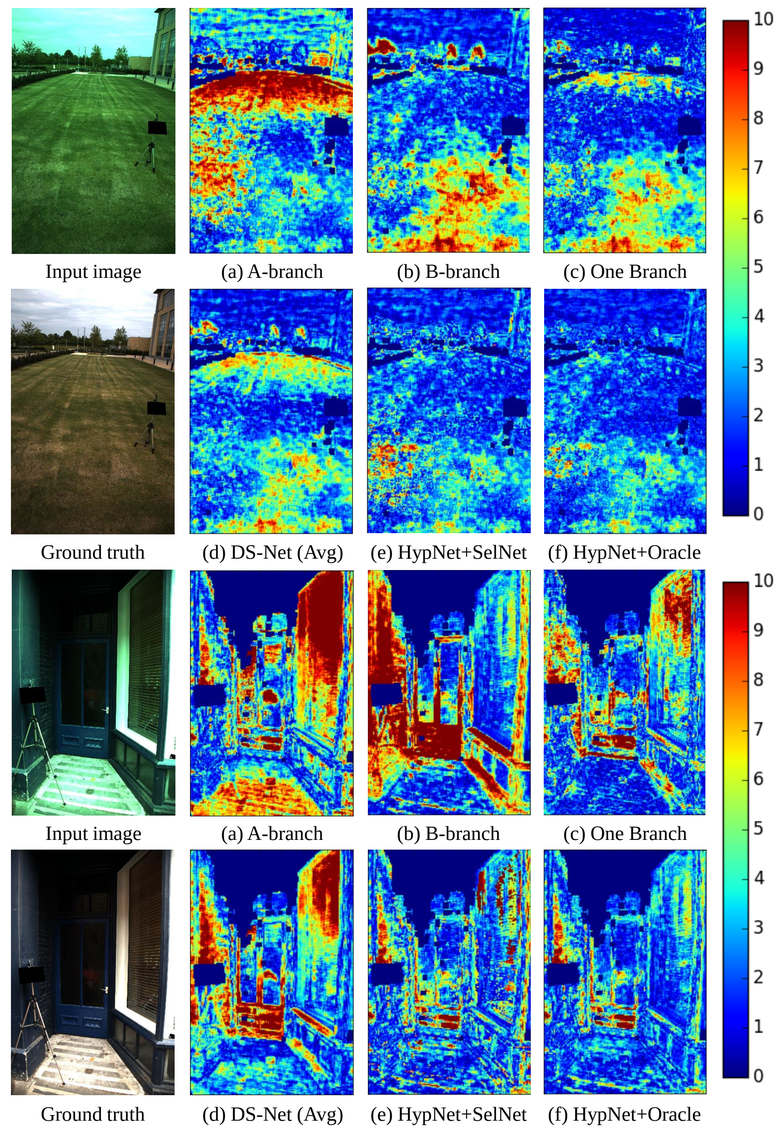


Figure 2: Different selection schemes.