Color Constancy using 3D Scene Geometry

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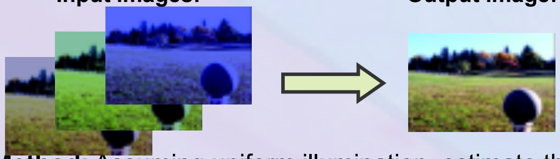
Color Constancy

- **Input:** image **f** taken under unknown light source.
- **Objective:** image **f**, as it appears under a canonical light.



- **Method:** Assuming uniform illumination, estimate the color of the light source, followed by color correction using diagonal transformation. Any illuminant estimation method can be used, e.g. White-Patch, Grey-World, Shades-of-Grey, Grey-Edge, 2nd-order Grey-Edge [1].
- **Research questions:**
  1) Can illuminant estimation be improved by explicitly using 3D scene geometry?
  2) Do different regions contribute equally to accurate estimation of the color of the light source?

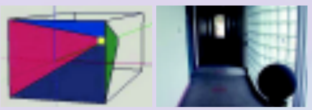
Stage Models

- **Stages**: 3D geometry models of a scene [2].
- **Examples**:

sky+background+ground

background +ground

box



1side-wallLR

Proposed: using 3D Geometry

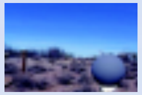
- The proposed method consists of the following steps:

Offline:

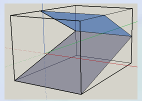
- Train stage classifier (e.g. baseline of the Pascal Visual Object Classes Challenge [3]).
- Learn optimal algorithm for every stage and segment.

Online:

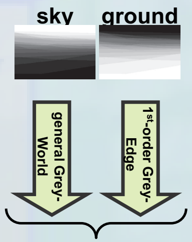
- Extract features for input image.



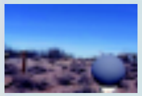
- Classify input image into one of the stages, e.g. "sky-ground".



- Process different segments of the classified stage independently, either using hard or soft segmentation.
- Use the appropriate algorithm for every segment



- Combine estimates into single estimate and correct the input image.



Evaluation: Stage Classification

- Stage classification on data set used for color constancy.
- Performance measure: average precision (AP)

Stage	% in data set	AP
skyBkgGnd	9.1%	0.65
bkgGnd	9.9%	0.34
skyGnd	2.7%	0.34
Gnd	12.1%	0.67
GndDiagBkgLR	6.6%	0.16
GndDiagBkgRL	4.6%	0.16
Box	8.0%	0.37

Stage	% in data set	AP
diagBkgLR	4.6%	0.12
diagBkgRL	3.8%	0.15
1side-wallLR	12.9%	0.46
1side-wallRL	15.6%	0.41
Corner	6.5%	0.15
PersBkg	3.5%	0.19
MAP	**0.320**	

Evaluation: Color Constancy

- Evaluation on a subset of [4]: 711 images for which ground truth is known.
- Angular error: median angular distance between estimated illuminant $\mathbf{e}$ and ground truth $\mathbf{u}$:

$$\epsilon = \cos^{-1}\left(\frac{\mathbf{e}\cdot\mathbf{u}}{||\mathbf{e}||\cdot||\mathbf{u}||}\right)$$

- Comparison to state-of-the-art:

Method	ϵ	Method	ϵ
Grey-World	7.0°	**Proposed**: no segmentation (auto)	4.8°
White-Patch	6.1°	**Proposed**: hard segmentation (auto)	4.5°
General Grey-World	5.8°	**Proposed**: soft segmentation (auto)	4.6°
1st-order Grey-Edge	5.2°	**Proposed**: no segmentation (manual)	4.6°
2nd-order Grey-Edge	5.4°	**Proposed**: hard segmentation (manual)	3.7°
		Proposed: soft segmentation (manual)	3.6°

Conclusion

- Taking into account 3D scene geometry improves state-of-the-art color constancy methods with 8% (12% using ideal classifier).
- Assigning different weights to different geometric regions improves state-of-the-art color constancy methods with 14% (over 31% using ideal classifier).

References

[1] van de Weijer et al. *Edge-based color constancy*, TIP: 16(9), 2007.
[2] Nedović et al. *Depth information by stage classification*, ICCV, 2007.
[3] van de Sande et al. *Evaluation of color descriptors for object and scene recognition*. CVPR, 2008.
[4] Ciurea et al. *A large data set for color constancy research*, CIC, 2003.