Hazy Images Dataset With Localized Light Sources For Experimental Evaluation Of Dehazing Methods

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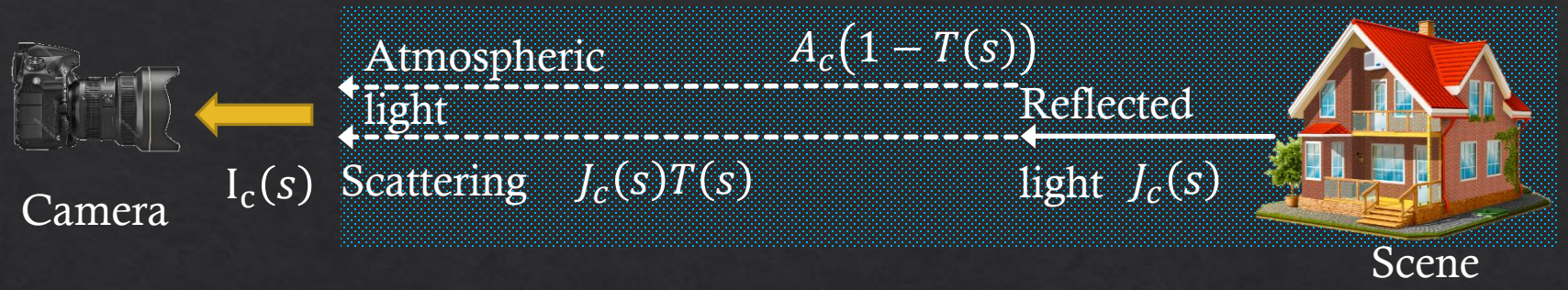
Image dehazing task

Original image

Dehazed image

Atmospheric scattering model



$$I_c(s) = J_c(s)T(s) + A_c(1 - T(s)), T(s) = e^{-\beta d(s)},$$

β – scattering coefficient, d(s) – scene depth, T(s) – transmission map,
$c \in \{R, G, B\}$ - color in the RGB color space

$I_c(s)$

$J_c(s)$

$T(s)$

* Koschmieder H (1924) Theorie der horizontalen Sichtweite. Beitr Phys freie Atmos 12:33–55

Dehazing datasets with ground truth

Haze type	Name	Number of images
synthetic	D-hazy[1]	1400+
	Reside[2] (SOTS, OTS)	2560+
real	BeDDE[3]	208
	Dense-haze[4]	33
	I-haze[5]	30
	NH-haze[6]	55
	O-haze[7]	45

Atmospheric scattering model:

$$I_c = J_c(s)T(s) + A_c\big(1 - T(s)\big);$$

$T(s)$ in case of hazy images synthesizing - is the depth map

[1] Ancuti C., Ancuti C. O., DeVleeschouwer C. D-hazy: A dataset to evaluate quantitatively dehazing algorithms //2016 IEEE international conference on image processing (ICIP). – IEEE, 2016. — С. 2226-2230.

[2] Li B. et al. Benchmarking single-image dehazing and beyond //IEEE Transactions on Image Processing. – 2018. — Т. 28. – №. 1. – С. 492- 505.

[3] S. Zhao, L. Zhang, *et al.* Evaluation of defogging: A real-world benchmark dataset, a new criterion and baselines. In *ICME*, pp.1840-1845, 2019.

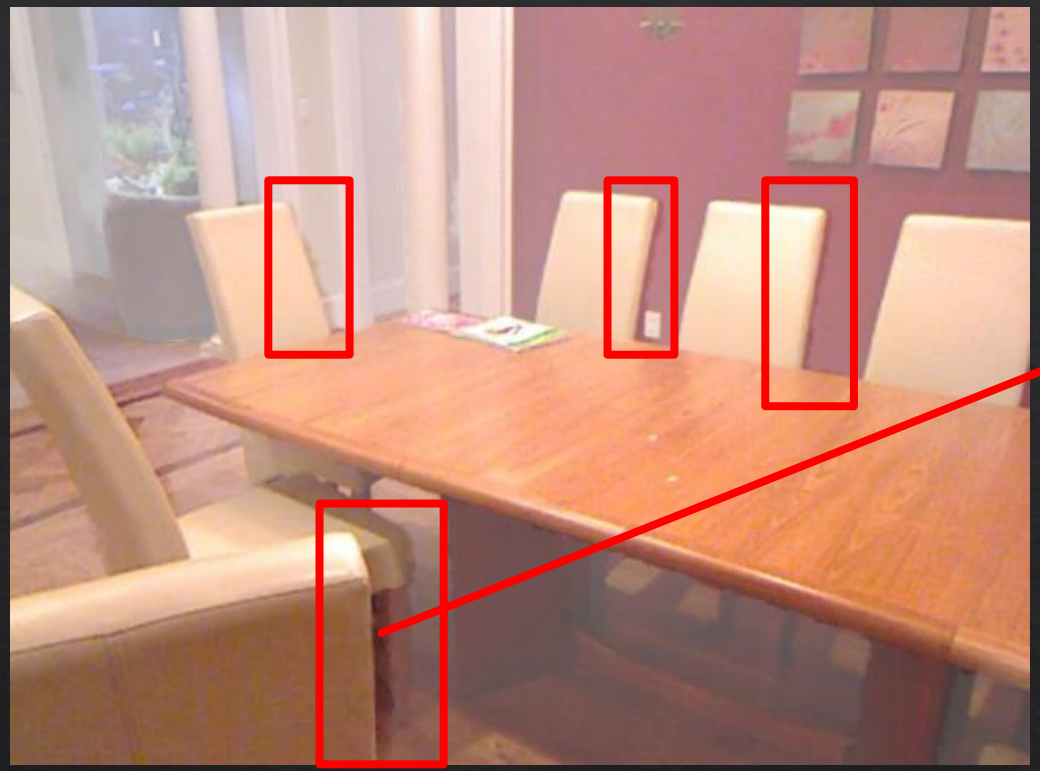
[4] Ancuti C. et al. Dense-haze: a benchmark for image dehazing with dense-haze and haze-free images //2019 IEEE international conference on image processing (ICIP). – IEEE, 2019. – С. 1014-1018.

[5] Ancuti C. et al. I-HAZE: a dehazing benchmark with real hazy and haze-free indoor images //International Conference on Advanced Concepts for Intelligent Vision Systems. – Springer, Cham, 2018. — С. 620-631.

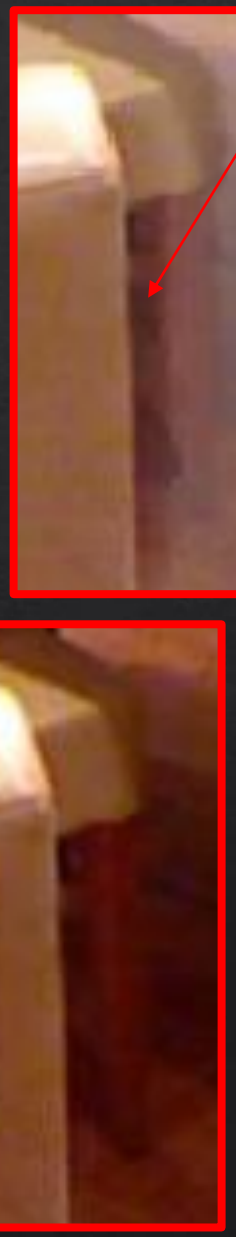
[6] Ancuti C. O., Ancuti C., Timofte R. NH-HAZE: An image dehazing benchmark with non-homogeneous hazy and haze-free images //Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition Workshops. – 2020. — С. 444-445.

[7] Ancuti C. et al. O-haze: a dehazing benchmark with real hazy and hazefree outdoor images //Proceedings of the IEEE conference on computer vision and pattern recognition workshops. – 2018. — С. 754-762.

Problem of synthetic haze



Synthetic haze image



improperly generated haze

Ground truth image

Images from SOTS dataset. Red squares are visible haze distortion areas

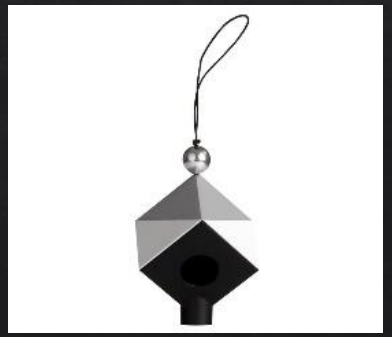
Haze removal in low light conditions with artificial light sources

Original image

Dehazed image

Basic principles of hazy images collection

- The most straightforward way to achieve a hazy environment is **using a smoke machine**
- For more homogeneous haze, **windlessness** should be held on a few minutes before taking pictures
- ColorChecker plate should be placed on the camera field of view. Optionally, also place other camera calibration tools.
- The camera parameters (aperture, shutter speed, ISO) should be controlled

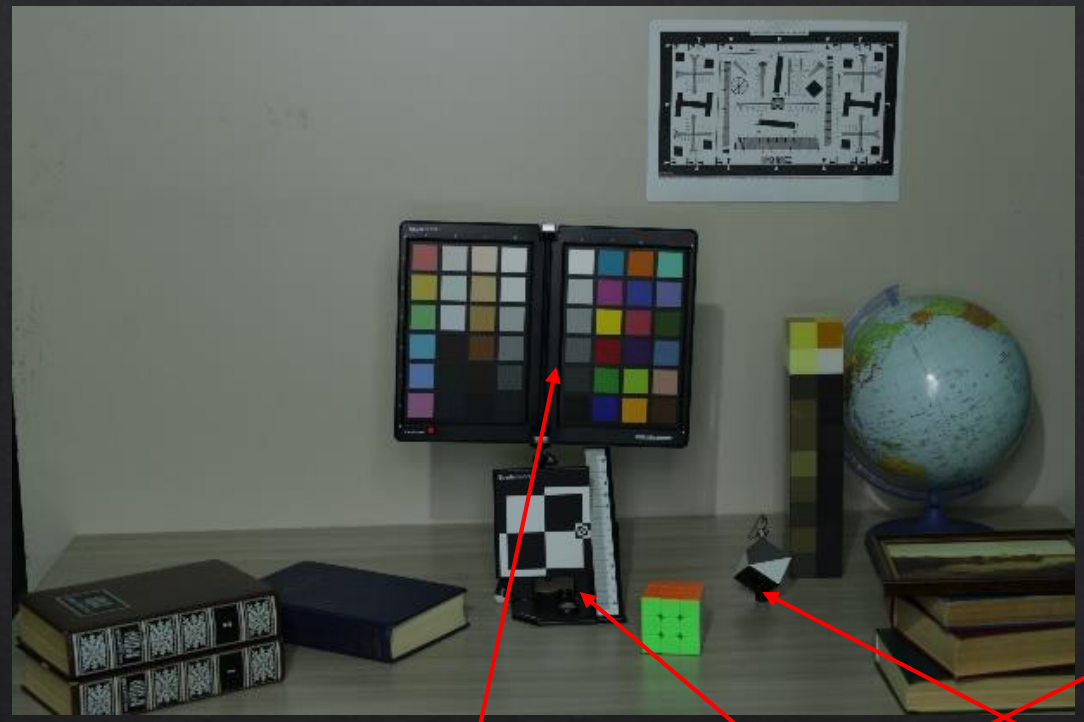


White balance tool
(Datacolor SpyderCUBE)

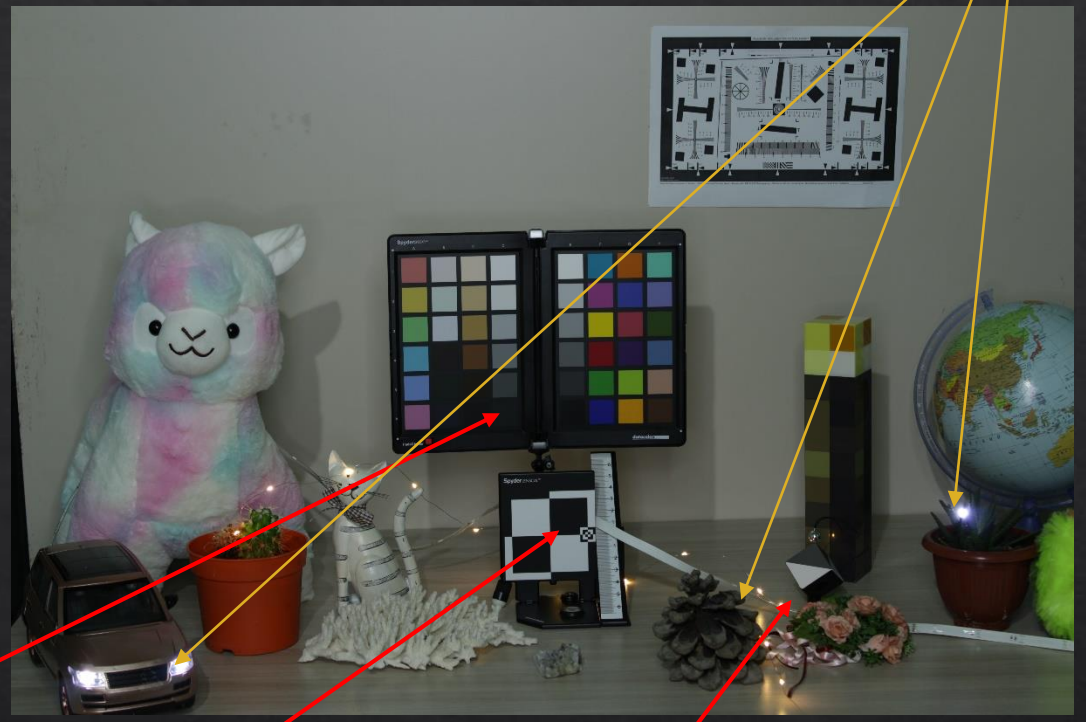
ColorChecker
(Datacolor SpyderCheckr)

Camera Lens Calibration Tool
(Datacolor SpyderLensCal)

Dataset collection. Scene complexity



Scene 1 (easy)



Scene 2 (advanced)

Localized light sources

Datacolor SpederCheckr

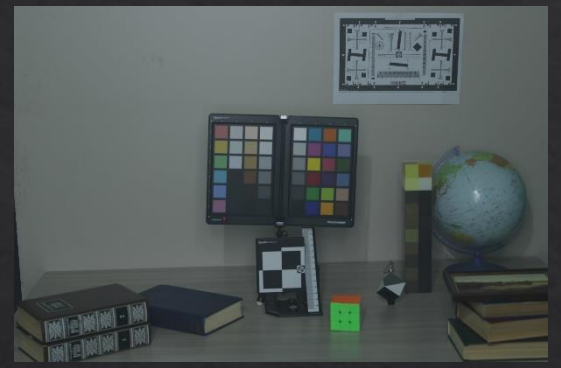
Datacolor SpyderLensCal

Datacolor SpyderCUBE

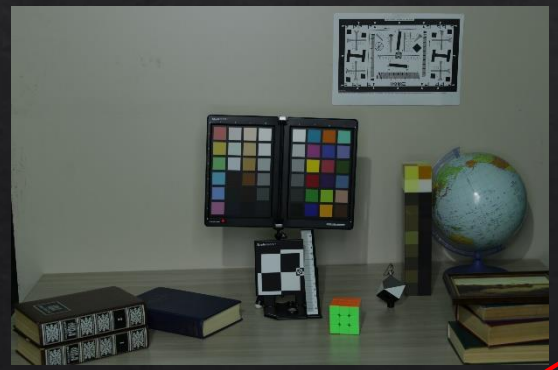
Dataset collection. Environment

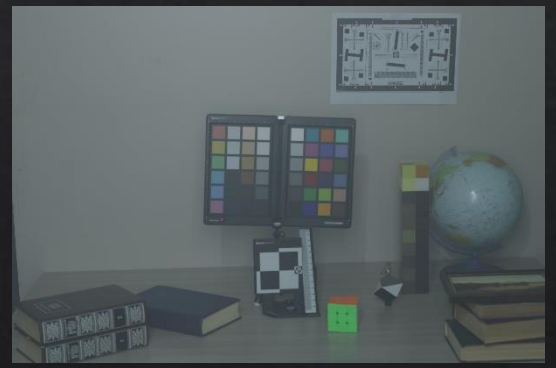
Increasing brightness



Increasing haze density






Datacolor SpederCheckr

Datacolor SpyderLensCal

Datacolor SpyderCUBE

Dataset collection. Backstage

Experimental evaluation

Mean of i-haze and o-haze datasets

Метод	Mean PSNR	Mean SSIM
Zhu et al.[12]	16.58	0.70
Berman et al.[8]	15.76	0.74
Qin et al.[11]	15.16	0.65
Dhara et al.[9]	14.85	0.67
He et al.[10]	13.51	0.62

Proposed dataset

Method	Mean PSNR	Mean SSIM
Qin et al.[11]	19.37	0.74
Dhara et al.[9]	18.59	0.71
Zhu et al.[12]	17.65	0.62
He et al.[10]	17.42	0.49
Berman et al.[8]	15.76	0.73

[8] Berman D. et al. Non-local image dehazing //Proceedings of the IEEE conference on computer vision and pattern recognition. – 2016. — С. 1674-1682.
[9] Dhara S. K. et al. Color cast dependent image dehazing via adaptive airlight refinement and non-linear color balancing //IEEE Transactions on Circuits and Systems for Video Technology. – 2020. – Т. 31. – №. 5. — С. 2076-2081.
[10] He K., Sun J., Tang X. Single image haze removal using dark channel prior //IEEE transactions on pattern analysis and machine intelligence. – 2010. – Т. 33. – №. 12. — С. 2341-2353.
[11] Qin X. et al. FFA-Net: Feature fusion attention network for single image dehazing //Proceedings of the AAAI Conference on Artificial Intelligence. – 2020. – Т. 34. – №. 07. — С. 11908-11915.
[12] Zhu Q., Mai J., Shao L. A fast single image haze removal algorithm using color attenuation prior //IEEE

THANK YOU FOR ATTENTION!