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BLOCK-BASED COLOR CONSTANCY: THE DEVIATION OF SALIENT PIXELS

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Color Constancy

The perceived color remains constant *regardless of the color of the light source*

- Performed *unconsciously* by the human visual system
- Machine vision systems have *difficulty to perform* such tasks

Aim of Color Constancy

To estimate the color vector of the light source $\mathbf{L}$

Obtain a canonical image from a color casted scene

$$I(x,y) = \int R(x,y,\lambda)\, E(x,y,\lambda)\, S(\lambda)\, d\lambda$$

$$L(x,y,\lambda) = \int E(x,y,\lambda)\, S(\lambda)\, d\lambda$$

- We cannot be sure about;
  - The type of the light source
  - The type of the capturing device

I: Image x, y: Pixel position R: Reflectance E: Light source
λ: Wavelength of the visible spectrum S: Sensor characteristics of the camera

Observations

- Human visual system might be estimating the illuminant of a scene based on;
  - ✓ Space-average color ✓ Highest luminance patch
- Color constancy studies based on our visual system are effective
  - ✓ Gray World ✓ maxRGB

Motivation and Aim of the Study

Not every pixel is informative for color constancy

- To improve our method with a simple yet effective approach
  - ✓ We reduce the impact of non-informative pixels
- To analyze whether our strategy is effective for other color constancy studies

Our Papers

← ICIP '22

ICASSP '23 →

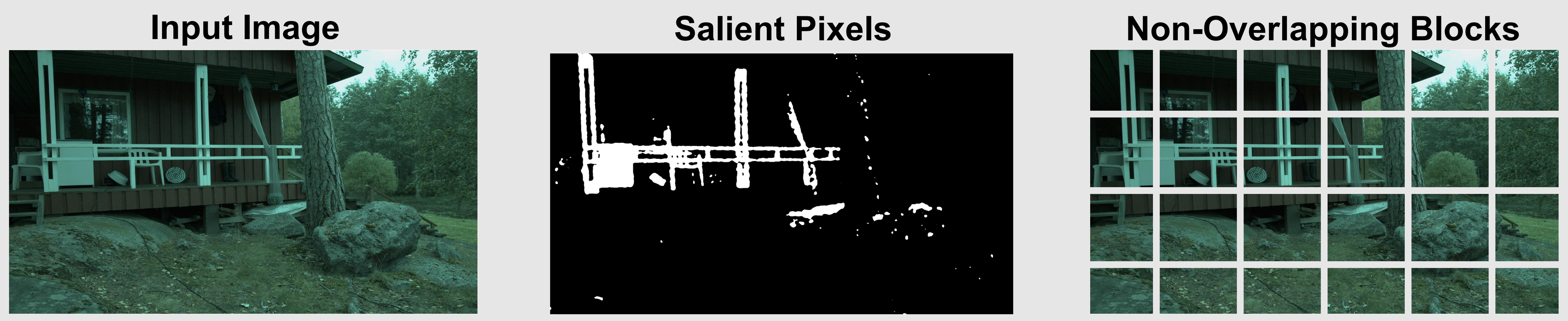
Assumption

1. The world is gray, on average
2. There are bright pixels somewhere in the scene

Main Idea

✓ If there is a shift from the gray world, it should be caused by the illumination condition of the scene

Proposed Method



1. Linearize the image
2. Clip the saturated pixels
3. Determine the salient pixels, i.e. whitest pixels
4. For each block containing salient pixels, find two informative elements;
   - The bright pixel, $I_{p,max} = \left[R_{p,max}, G_{p,max}, B_{p,max}\right]$
   - The unique achromatic value, i.e. gray value, μ_p
5. Find the deviation of $I_{p,max}$ from μ_p by using a scaling vector $\mathbf{C}_p = [c_r\ c_g\ c_b]$;

$$\mathbf{C_p} = \arg\min_{\mathbf{C_p}} \left\| I_{p,max}\, \mathbf{C_p} - \mu_p \right\|_2 \quad with \quad \forall c \in \mathbf{C_p} : c \geq 0$$

6. Find the estimate of the global illuminant;

$$\mathbf{L}_{est} = \sum_{p=1}^{n} \frac{\mathbf{C}_p}{n}$$

n: number of blocks
μ_p: mean over all channel values of I_p

Investigation of the Block Size

INTEL-TAU Random Set	8×8	16×16	32×32	64×64	128×128	300×300	600×600
Mean Angular Error	3.759	3.747	3.733	3.729	**3.725**	3.733	3.783

RECommended ColorChecker Random Set	8×8	16×16	32×32	64×64	128×128	300×300	600×600
Mean Angular Error	3.630	3.603	3.571	3.542	3.518	**3.492**	3.607

- The block sizes are experimentally determined by investigating the relationship between the mean angular error and different kernel sizes

Experimental Results

Table 1. Statistical results. For each metric best result is highlighted.

	INTEL-TAU				RECommended ColorChecker			
	Mean	Median	B.25%	W.25%	Mean	Median	B.25%	W.25%
White-Patch Retinex	11.01	13.16	1.81	19.44	10.27	9.12	1.64	20.50
Gray World	4.91	3.88	0.96	10.60	4.74	3.61	0.97	10.44
Shades of Gray Edge	5.51	4.16	0.97	12.29	5.87	4.25	0.75	13.72
1st order Gray Edge	6.10	4.23	0.96	14.27	6.42	3.84	0.94	15.83
2nd order Gray Edge	6.41	4.50	1.04	14.73	6.94	4.41	1.07	16.53
Weighted Gray Edge	6.00	3.64	0.81	14.90	6.10	3.33	0.79	15.59
Double-Opponent Cells based Color Constancy	7.19	4.67	0.81	16.98	7.24	4.26	0.80	18.05
PCA based Color Constancy	4.47	3.03	0.69	10.64	4.11	**2.52**	0.53	10.19
Local Surface Reflectance Estimation	4.17	3.42	0.98	8.61	4.03	3.07	1.40	8.17
Mean Shifted Gray Pixels	3.57	**2.56**	0.64	8.24	3.81	2.96	0.77	8.35
White-Patch Retinex: Block-based with Salient Pixels	3.41	2.65	0.79	7.36	4.05	2.93	0.94	8.99
Gray World: Block-based with Salient Pixels	3.69	2.58	**0.63**	8.60	4.39	2.80	**0.52**	10.85
Proposed: Without Blocks and Salient Pixels	8.74	7.89	1.74	17.08	9.23	7.49	2.79	18.11
Proposed: Without Blocks and with Salient Pixels	5.92	4.11	1.04	13.72	6.44	4.73	1.55	14.06
Initial Version	4.29	3.61	1.20	8.53	3.82	3.17	1.46	7.38
Proposed	**3.37**	2.63	0.79	**7.25**	**3.48**	2.71	1.06	**7.35**

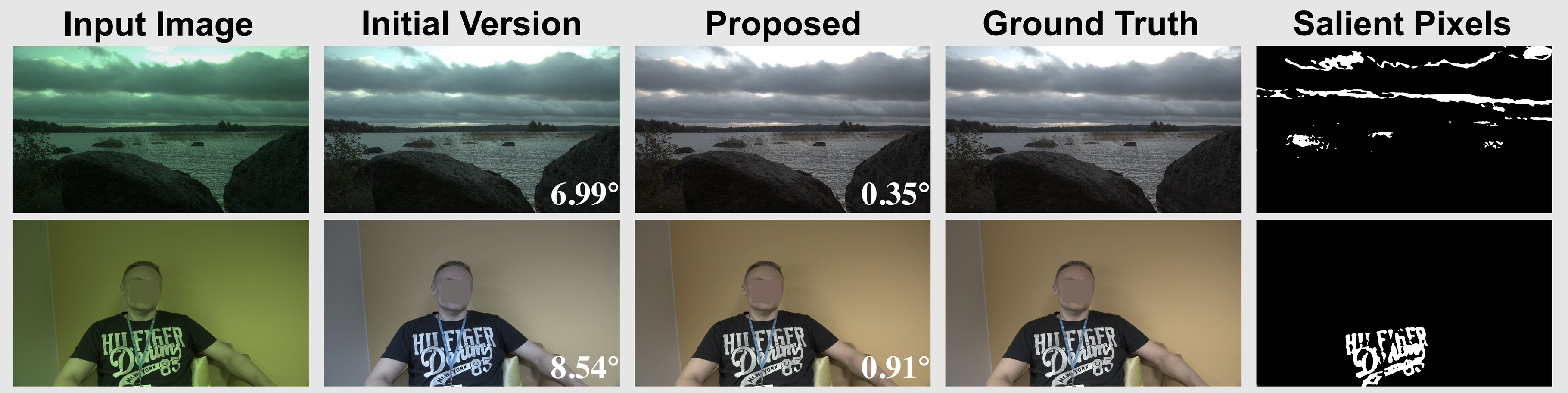


Figure. Comparison with the initial version.

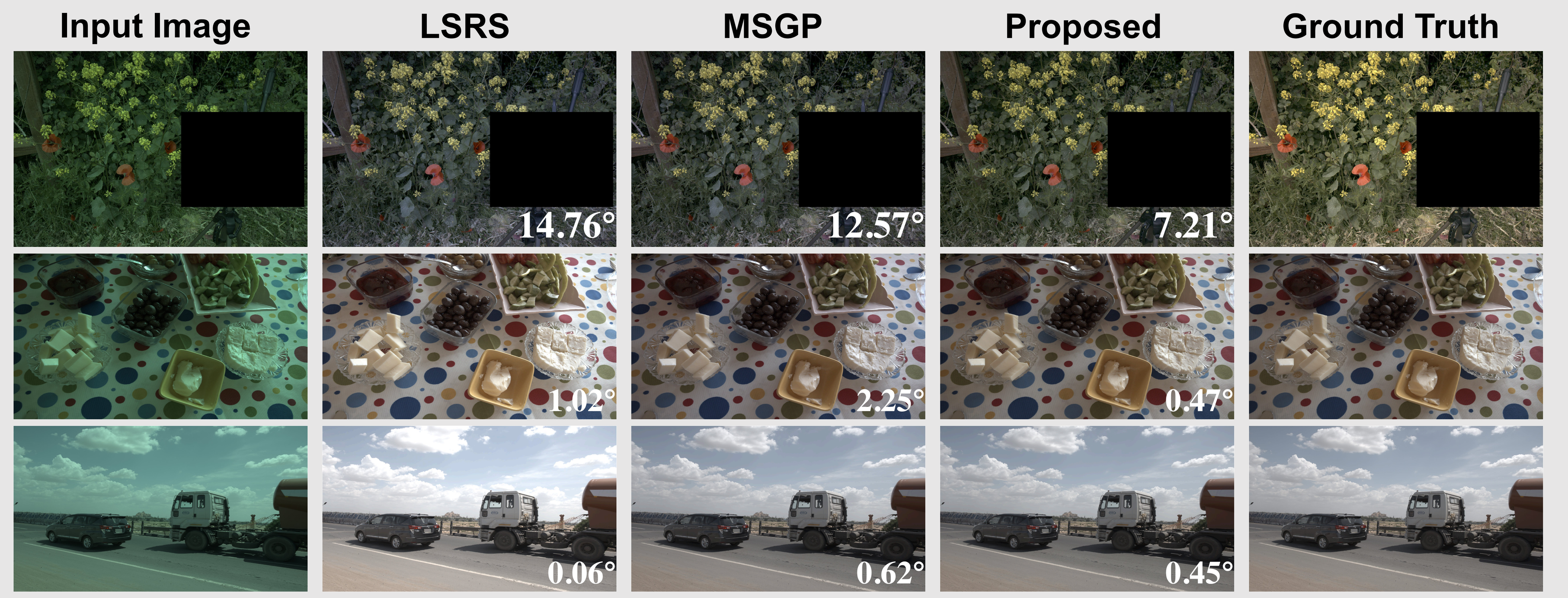


Figure. Comparison with the state-of-the-art.

Summary

- We recently proposed a learning-free algorithm relying on the assumptions
  - ✓ Gray World ✓ maxRBG
- We modified our algorithm by only considering the patches containing the salient pixels
  - ✓ Pixels closest to white
- We showed that applying our strategy to some other methods improves their effectiveness
  - ✓ Block-based approach ✓ Considering only the salient pixels