SUPPLEMENTAL MATERIAL: TWO-STEP COLOR-POLARIZATION DEMOSAICKING NETWORK

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1. ABSTRACT

This supplemental material provides additional experimental results which could not be included in the ICIP main paper due to limited space.

2. EXPERIMENTAL RESULTS

2.1. Datasets

We evaluated our proposed TCPDNet with two publicly available datasets: Tokyo Tech dataset [1] and CPDNet dataset [2]. In those two datasets, the ground-truth 12-channel full-color-polarization images were taken by a division-of-time polarimeter approach.

Tokyo Tech dataset includes 40 scenes of 1024×768 resolution. The evaluations were conducted on our splits: 30 scenes for the training set, two scenes for the validation set, and eight scenes for the testing set. CPDNet dataset includes 105 scenes of 1456×1088 resolution, in which 260 images are for training, 80 images are for validation, and 80 images are for testing. However, there is no public information about how their dataset is specifically split. Therefore, we conducted the evaluations based on our splits according to the above-mentioned published ratio.

2.2. Quantitative comparison

We compared our TCPDNet with five existing methods: bilinear interpolation, EARI [1], IGRI2 [3], CPDNet [2] (original), and CPDNet [2] (re-trained). The weight of CPDNet (original) is provided by the authors of [2], while we re-trained CPDNet (re-trained) with Tokyo Tech dataset. For the learning-based methods, each model was trained five times and averaged metric values were evaluated.

Tables 1 and 2 show the quantitative comparisons with Tokyo Tech dataset and CPDNet dataset where a higher CPSNR is better and a lower angle error is better. We evaluated four color-polarization images (I_0, I_{45}, I_{90}, and I_{135}), three Stokes parameters (S_0, S_1, and S_2), DoP, and AoP. From Table 1 and Table 2, we can find that the proposed TCPDNet clearly outperforms the other methods.

2.3. Qualitative comparison

Figures 1 and 2 visualize the results of different methods on Tokyo Tech dataset and CPDNet dataset, respectively. Our proposed TCPDNet produces less color artifacts while existing methods suffer from obvious color artifacts in S_0. In the Figure 1's second row example, CPDNet wrongly estimates red color region as blue. CPDNet's wrong color estimation is also highlighted in the Figure 2's second and third rows.

Our proposed TCPDNet is also the best in edge retention. In the Figure 1's first row example, the "IS" characters are not properly estimated by EARI and IGRI2. In the Figure 1's second row example, the country name almost disappears in these two method's estimation. In the Figure 2's first and second row example, the text edges estimated by the two method are also blurred. In the Figure 2's third row example, the leaf texture estimation by the two method looks smoother than expected. CPDNet's estimations are better than hand-crafted methods in general, yet its edge estimations are not as vivid as TCPDNet and suffer from distortion, e.g. the "IS" characters in the Figure 1's first row image.

The differences in AoP-DoP images are drastical amongst different methods. EARI and IGRI2 hardly preserves the edge information. The re-trained CPDNet generally give better estimations but not as close to the ground-truth as our TCPDNet.

3. REFERENCES

[1] Miki Morimatsu, Yusuke Monno, Masayuki Tanaka, and Masatoshi Okutomi, "Monochrome and color polarization demosaicking using edge-aware residual interpolation," *Proc. of IEEE Int. Conf. on Image Processing (ICIP)*, pp. 2571–2575, 2020.

[2] Sijia Wen, Yinqiang Zheng, Feng Lu, and Qinping Zhao, "Convolutional demosaicing network for joint chromatic and polarimetric imagery," *Optics Letters*, vol. 44, no. 22, pp. 5646–5649, 2019.

[3] Miki Morimatsu, Yusuke Monno, Masayuki Tanaka, and Masatoshi Okutomi, "Monochrome and color polarization demosaicking based on intensity-guided residual interpolation," *IEEE Sensors Journal*, vol. 21, no. 23, pp. 26985–26996, 2021.

Table 1: Performance comparison on Tokyo Tech dataset.

Method	CPSNR								Angle error
	I_0	I_{45}	I_{90}	I_{135}	S_0	S_1	S_2	DoP	AoP
Bilinear interpolation	34.64	34.27	35.19	34.46	36.01	42.05	39.93	30.33	23.70
EARI [1]	38.33	37.58	39.00	37.77	39.81	45.47	42.82	32.95	20.54
IGRI2 [3]	38.40	37.59	39.07	37.78	39.60	46.38	43.05	33.17	20.05
CPDNet (original) [2]	23.02	24.26	24.33	24.43	24.64	32.35	38.96	24.85	50.42
CPDNet (re-trained) [2]	28.01	27.81	28.10	27.81	28.23	45.23	41.84	31.24	32.32
TCPDNet (Ours)	**43.73**	**43.16**	**44.46**	**43.31**	**44.91**	**52.82**	**48.86**	**38.74**	**12.65**

Table 2: Performance comparison on CPDNet dataset.

Method	CPSNR								Angle error
	I_0	I_{45}	I_{90}	I_{135}	S_0	S_1	S_2	DoP	AoP
Bilinear interpolation	35.11	35.07	34.90	35.03	37.24	40.50	40.62	27.90	29.15
EARI [1]	36.83	36.90	36.79	36.84	39.74	41.51	41.75	28.62	28.91
IGRI2 [3]	36.91	36.97	36.86	36.92	39.41	42.01	42.30	28.99	28.43
CPDNet (pre-trained) [2]	36.92	37.12	36.73	36.80	39.67	41.66	42.01	27.31	31.47
CPDNet (re-trained) [2]	36.70	36.43	36.36	36.19	39.03	41.94	41.99	28.46	30.17
TCPDNet (Ours)	**39.76**	**39.83**	**39.72**	**39.78**	**43.16**	**44.06**	**44.35**	**30.17**	**25.64**

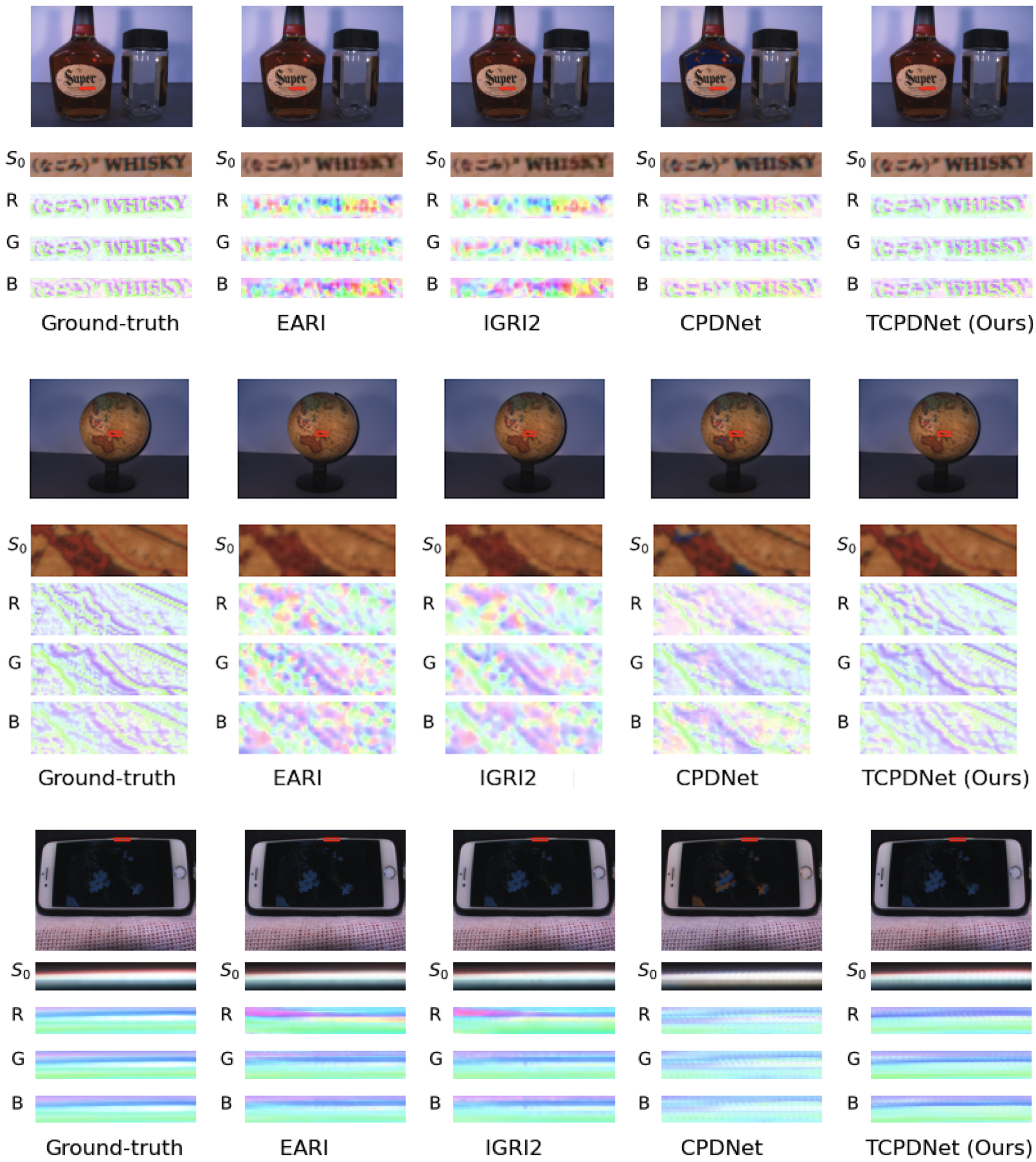

Fig. 1: Qualitative comparison between our proposed TCPDNet and existing methods. The scenes are from Tokyo Tech dataset.

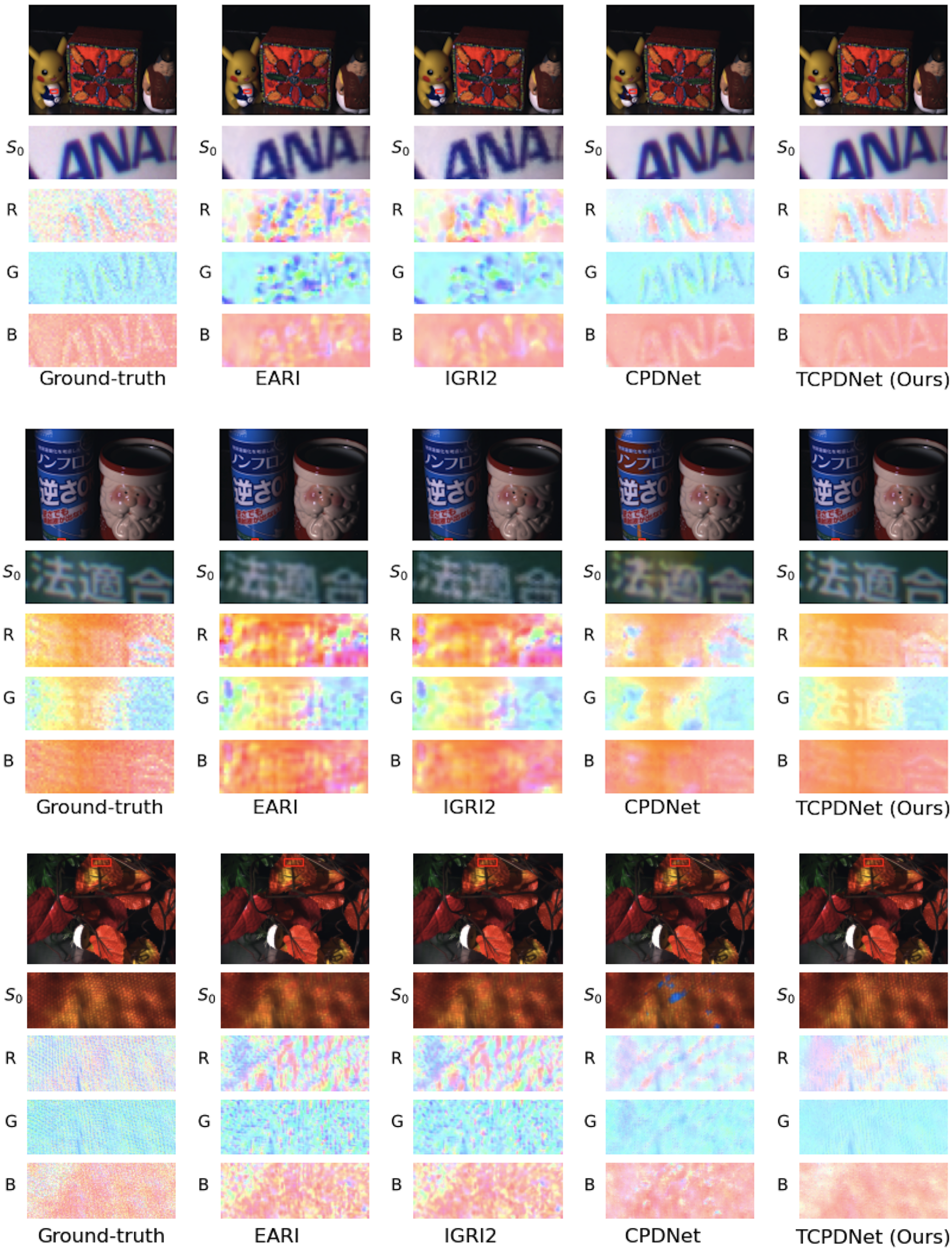

Fig. 2: Qualitative comparison between our proposed TCPDNet and existing methods. The scenes are from CPDNet dataset.