# Supplementary for "Matching in the Dark: A Dataset for Matching Image Pairs of Low-light Scenes"

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#### A. Distinction from Existing Datasets

Figure 7 shows example images of our dataset and RobotCar [33]. Most of our images are darker than the darkest one of RobotCar. The standard raw image processing yields mostly black images from them. Nevertheless, one can derive sufficient info from their RAW signals, when treating them properly.

## B. Performance Comparison to a Manual Adjustment

Figure 8 shows the results of using SuperPoint with the three image-enhancing methods and the result obtained by using SuperPoint on a manually converted 8-bit image from the same RAW image. To be specific, we manually chose the range of 14-bit RAW signal and converted it into an 8-bit image. The values of 'dR' and 'dT' indicate the rotation and translation errors for each method. It is observed that the manual method yields significantly better results than others and indicates that there is stil much room for improvement.

#### C. All Samples of Scene Images in the Dataset

Figures 9 and 10 show all samples of indoor and outdoor scenes in our dataset, respectively. All images are obtained from the long exposure RAW-format images by the standard RIP.

#### **D.** More Results of Image Matching

Figure 11 shows the normalized number  $N_{\tau}$  of the exposure settings for which the estimation error is lower than threshold  $\tau$  averaged over 54 *outdoor* scenes.

Figure 12 shows the average angular errors of the camera pose estimated by the compared 88 methods (i.e., eight image enhancers with eleven image matching methods) over all scenes for each of the  $6 \times 8$  exposure settings.

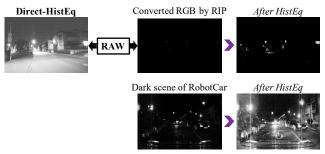


Figure 7. Comparison between RobotCar [33] and our dataset.

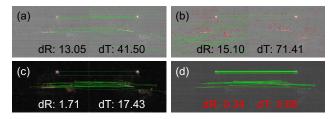


Figure 8. Matching results of **SP** with (a) **Direct-HistEq**, (b) **Direct-BM3D**, (c) **SID**, and (d) Images obtained by manual adjustment of brightness range in 14-bits RAW signals.

### E. Visualization of Matching Results

Figure 13 and 14 show examples of the visualization of the matching results by the 88 methods for an indoor and an outdoor scene, respectively.

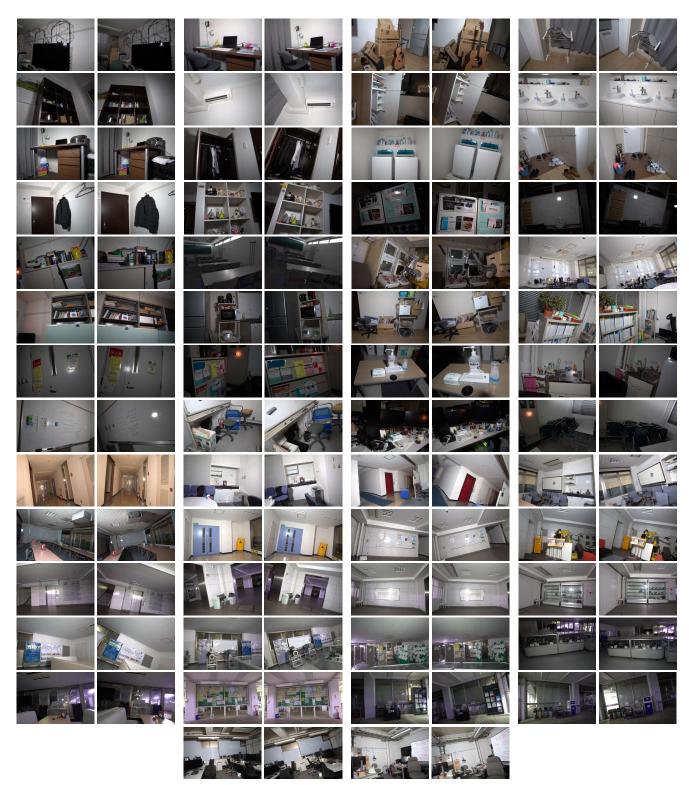


Figure 9. Samples of all image pairs (long exposure versions) of the indoor scenes.

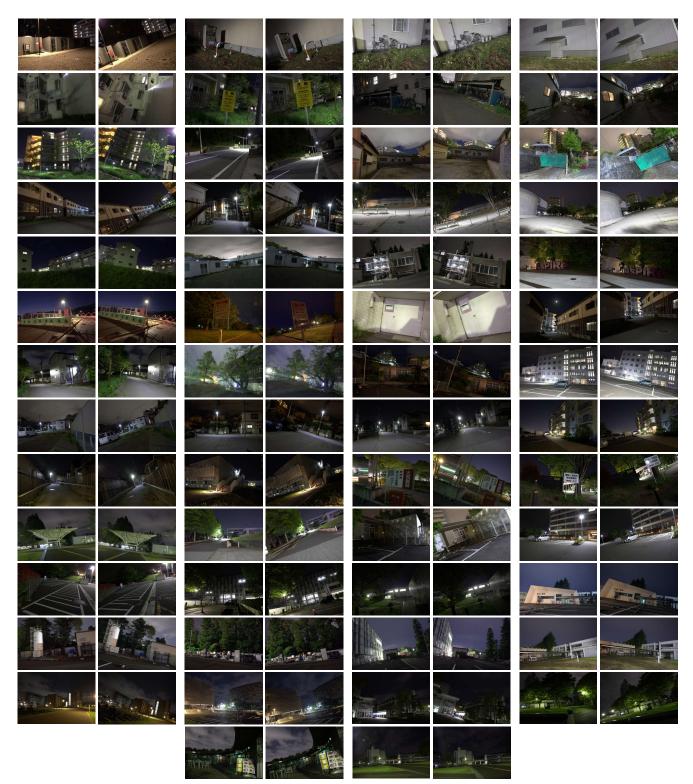


Figure 10. Samples of all image pairs (long exposure versions) of the outdoor scenes.

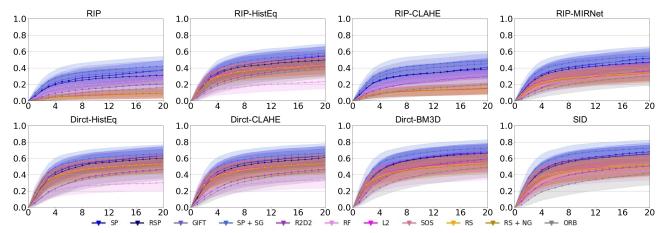


Figure 11. The normalized number  $N_{\tau}$  of the exposure settings (the vertical axis) for which the estimation error of each method is lower than threshold  $\tau$  (the horizontal axis). Each panel shows the means and standard deviations over 54 *outdoor* scenes for the eleven image matching methods for an image-enhancing method.

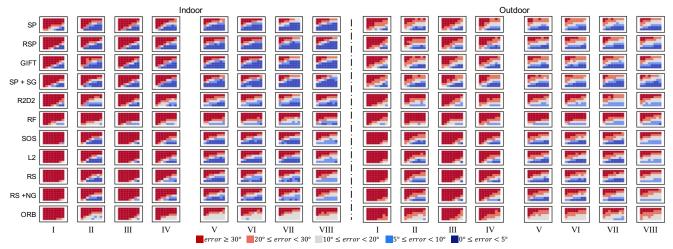


Figure 12. Average angular errors of the camera pose estimated by the 88 methods (i.e., eight image enhancers with eleven image matching methods) over all the 54 scenes for each of the  $6 \times 8$  exposure settings. (I) **RIP**. (II) **RIP**-**HistEq**. (III) **RIP**-**CLAHE**. (IV) **RIP**-**MIRNet**. (V) **Direct-HistEq**. (VI) **Direct-CLAHE**. (VII) **Direct-BM3D**. (VIII) **SID**.

		RIP	RIP-HistEq	RIP-CLAHE	RIP-MIRNet	Dirct-HistEq	Dirct-CLAHE	Dirct-BM3D	SID
Easy	SP	dR:19.78dT:7.79	dR:1.22 - 01-0-75	dR-20.84 dT:72.71	dR:2.63 -47:2-49				dR-0 21 dr + 60
	RSP	dR:180.0dT:180.0	dR:1.39 dT0.9	dR:180.0dT:180.0	dR:13.16dFr22.33		1		dR-2 14 d1240
	GIFT	dR-180.0dT:180.0	dR:3 09 47-148	dR:17.22dT:48.46	dR:7.18-dT:4.91		<b>desta</b> ta		dR-0 19 dE0-85
	SP+SG	dR-180.0dT-180.0	dR:11.5541-10-12	dR:123.587-86.91	dR:11.05.47:16:09				dR:1.43 (dF:0.12)
	R2D2	dR-180.0dT:180.0	dR-6 58 dTh110	dR:180.0 dT:180.0	dR:3.0 11324				dR:1.0 d7:2.55
	RF	dR-180.0dT:180.0	dR:180.04T:180.0	dR:180.0 dT:180.0	dR-25 21 dT-89 94				dR:1.48_dT:1.69
	L2	dR-180.0dT:180.0	dR-0.49 .41:0-85	dR-180.0dT:180.0	dR:148.477.54.89			. <b></b>	dR:116.000/2
	sos	dR-180.0dT:180.0	dR-0.31 att038	dR:180.0dT:180.0	dR:22.34dT:63.21				dR:1.91. ar0.01
	RS	dR-180.0dT:180.0	dR:0.3 d1:0.51	dR-180.0dT:180.0	dR:148.887.54.86				dR-0 36 atono
	RS+NG	dR-180.0dT:180.0	dR:5.11 dT:6.2	dR-180.0 dT:180.0	dR:17.74dT:47.81		Jahr Da		dR-1 22, 410 79
	ORB	dR-180.0dT:180.0	dR:2.01 d1:2.64	dR-180.0 dT:180.0	dR:18.24d7.52.26				dR-4.89. 41-5.09
I	SP					all me	the land and	the later of a	a section
		dR:180.0dT:180.0	dR:180.0 dT:180.0	dR:20.84 dT:72.97	dR:20.84 dT:15.7	dR 16 69 61 44 82	dR-20,85.47.88.19	dR-29 52dT-80 64	dR:18.23dT:41.47
	RSP	dR:180.0dT:180.0	dR:180.0 dT:180.0	dR:180.0 dT:180.0	dR:173.947:76.73	dR:19.0901:33.63	dR:157 187.71 53	dR:46.846T:4.48	dR-8 68 . dl. 11 . 39
	GIFT	dR-180.0dT-180.0	dR-20.85 dT-41.39	dR-180.0dT-180.0	dR 36 78dT 17 82	dR:24.09 gt 70.56	dR:11.194T;18.93	dR: 14 (36 dT) 25 88	dR.8.5 df.10-73
	SP+SG	dR-180.0dT:180.0	dR:180.0 dT:180.0	dR-180.0dT:180.0	dR:180.047:180.0	dR:11.59et:15.79	dR-1.02 dT-2.32	dR:11.714Th21.34	dR.7.32.41947
	R2D2	dR-180.0dT:180.0	dR:180.0 dT:180.0	dR:180.0dT:180.0	dR:31.3347:65.7	dR:177.481.57.19	dR:105.141.86.59	dR-20-68-61-74-89	dR:17.57d1.78.36
Hard	RF	dR-20.75dT:17.51	dR-55.85 dT-60.25	dR 20.8 dT:72.49	dR-51.99 dT-86-8	dR: 180 001, 180 0	dR-180.047:180.0	dR 180.0 et 180.0	dR:54.08dT:77.8
	L2	dR-180.0dT:180.0	dR:180.0 dT:180.0	dR:180.0 dT:180.0	dR:180.0dT:180.0	dR-180.041.180.0	dB:148.04T.68:68	dR:180.0et.180.0	dR:16.64dT:45.01
	sos	dR-180.0dT-180.0	dR:180.0 dT:180.0	dR:180.0 dT:180.0	dR:180.0 d7:180.0	dR-180.0 eff-180.0	dR:104.581733.97	dR:122.397548.17	dR:180.047:180.0
	RS	dR-180.0dT-180.0	dR:180.0 dT:180.0	dR-180.0 dT-180.0	dR:180.0 dT:180.0	dR-161 181-58 27	dR:167.387.64.3	dR:158 83754 76	dR:170 187:51 67
	RS+NG	dR-180.0dT-180.0	dR:180.0 dT-180.0	dR-180.0 dT-180.0	dR:180.0dT:180.0	dR:12.6541.05.03	dR-169.547.59.47	dR:137 597:53.14	dR:17.7 dT:55.07
	ORB	dR-180.0dT-180.0	dR:180.0 dT 180.0	dR-180.0dT-180.0	dR:180.0dT:180.0	4R.179 Balto4.63	dR:21.05d1704	dR: 100 507:45 86	dR.7.22 dt.6.19

Figure 13. Visualization of the matching results for one of the 54 indoor scenes. Point correspondences judged as inliers are shown in green lines. The combination of eleven matching methods and the eight image enhancing methods are applied to two image pairs with different levels of exposure (i.e., 'Easy' and 'Hard').

		RIP	RIP-HistEq	RIP-CLAHE	RIP-MIRNet	Dirct-HistEq	Dirct-CLAHE	Dirct-BM3D	SID
Easy	SP	dR-0.15 dT-0.47	dR-0.39 dT free	dR 0.08 dT:0.64	dR.0.27 dT.045	attooos and so	atto a and an	areo 1 arts 20	dR 0.1 dT:015
	RSP	dR-0.36 dT-0.8		dR:0.45 dT*2.79	dR:0.07 dT:0.04			AR 0 55 er s.2	dR:0.13 df:0.80
	GIFT	dR 0.44 dT 1 99	dr.021 dr.000	dR-0.1 dT-11-40	dr.0.16 dt.1.64		HEO 25 MP IL	artist ar 24	dR 0.06 dY 0-29
	SP+SG	dR-0.13 df-1-73	dR 0.05 err#14	dR-0.05 an 0-79	dR014 drn te				dR 0.07 df 0.77
	R2D2	dR-10.21dT:81.24		dR.0.65 dT.2.20	dR.0.9 dT483				dR 0.25 dT 1.47
	RF	dR 0.46 dT 1.93	dR042 dT2	dR-0.28 dT:1.0	dR0 82 dT11				dR 0 15 dt 1 34
	L2	dR-180.0dT-180.0	NIT ALL ALL ALL ALL ALL ALL ALL ALL ALL AL	dR-180.0 dT-180.0	dR 0.58 dT 2 1				
	sos	JD-190 0 JD-190 0		40-180-6-35-180-6					
	RS	UE 100 0 JE 100 0		UN 100 0 10 100 0					
	RS+NG	dk:100.0d1:100.0		ar: 190.041: 190.0	dr.0.47 dr.1.0				droue droue
	ORB	dR:163.02T-51.49	dR0.17 dh0ta	dR:180.0dT:180.0	dR-0.06 dT-0.09				dR.0.15 dT:F08
		dR-174.6 <b>a</b> T-49.91	dR.0.54 dTr Date of the	dR-25.3 dT-66.67	dR:0.12 dT:043	ar.o.28 ar h <del>ai an 17</del>	dR:0.09 d7:4724 artitility		dR:0.26 dT:200
	SP	dR-18.03 dT-21.37	dR:34.36 dT:71.81	dR:18.03 dT:22.99	dR:18.03 dT:22.29	dR0.89 dT.2.2	dR:0.54 dT:1.33	dR0.6 dT227	dR:2.27 dT:1116
	RSP	dR:180.0dT:180.0	dR:180.0 dT:180.0	dR-180.0 dT-180.0	dR:180.0 dT:180.0	dR:134 dT:818	dr.0 92 dT 3 08	dR:103 dT:40	dR-1.44 dT-702
	GIFT	dR:180.0dT:180.0	dR:5.16 dT:77.72	dR-180.0dT:180.0	dR.2.15 dT.81.02	dR 0.48 dT 1/29	dR 1 99 dT 7 03	ar.0.43 at 243	dR 0.94 dT 4 78
	SP+SG	dR-180.0dT:180.0	dR:125.69T:45.31	dR-180.0dT:180.0	dR-31.88 dT-34-7	dR:0.4 dT-1/24	dR:1 09 dT:5.09	dR:0.4 dT:0.66	dR 0.38 dr 2 75
Hard	R2D2	dR:180.0dT:180.0	dR:10.77 dT:75.92	dR-180.0dT-180.0	dR-20.97dT-46.57	dR-5.22 dT-20- <u>09</u>	dR:12.5 dT:05:26	dR:7:27 dT35.44	dR-11.18dT-37.09
	RF	dR:18.01dT:28.56	dR:10.77dT:31.82	dR:18.0 dT:45.28	dR:19.16dT:65.92	dR: 180.0 dT: 180.0	dR:180.047:180.0	ar 28 92 at 76 39	dR:1.65 dT:5.3
	L2	dR-180.0dT:180.0	dR:180.0dT:180.0	dR-180.0 dT-180.0	dR:180.0d7:180.0	dR: 10.56 dT: 37.57	dR.5.66 dT 221	alk 3 24 dT 1627	dR:L.14 dT:50
	sos	dR-180.0dT:180.0	dR:180.0dT:180.0	dR-180.0dT:180.0	dR:180.0d7:180.0	dR:2.77 dT:13.06	dR:295 dT:142	dR0.76 dT2.91	dR3.46 dT17.3
	RS	dR-180.0dT:180.0	dR:180.0dT:180.0	dR-180.0dT:180.0	dR:180.0d7:180.0	dR:8.95 dT-4521	dR:2 77 dT:1326	dR:0.9 dT-607	dR-0.2 dT-1
	RS+NG	dR:180.0dT:180.0	dR:144.58T:47.41	dR-180.04T-180.0	dR:180.0d7-180.0	db/2.67 dT 1518	db.2.78 d7.1785		dR105 dT 300
	ORB	dR-180.04T-180.0	dR:1.49 dT:24.91	dR-180.0dT-180.0	dR:178.64T:46.48	dR-3.26 dT 16.57	4R/3 67 47 (16.0)	dR 3 51 dT 17.9	dR 0.59 dT/241

Figure 14. Visualization of the matching results for one of the 54 outdoor scenes. Point correspondences judged as inliers are shown in green lines. The combination of eleven matching methods and the eight image enhancing methods are applied to two image pairs with different levels of exposure (i.e., 'Easy' and 'Hard').