

DeSmoke-LAP: Improved Unpaired Image-to-Image Translation for Desmoking in Laproscopic Surgery

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Supplementary Material

2 *DeSmoke-LAP*

1 Information of the organised dataset

Table 1 summarises our robot-assisted laparoscopic hysterectomy dataset. This dataset will be made publicly available along with the paper publication.

Table 1 Summary of the organised clear and hazy dataset used in our paper. The data is divided into 5 folds for cross-validation. For each video, its fold number, frame resolution, number of selected frames, number of selected clear and hazy frames are presented. For testing the consistency of the proposed DeSmoke-LAP across frames, short video clips are also selected from each video and used for the evaluation.

Fold	Video Name	Image Resolution (pixels)	Total No. of Frames	No. of Frames Clear	No. of Frames Hazy	Length of Clip # Frames
1	PG002	480x360	600	300	300	50
	PG006	720x540	600	300	300	50
2	PG007	720x540	600	300	300	50
	PG008	720x540	600	300	300	50
3	PG010	720x540	600	300	300	50
	PG011	720x540	600	300	300	50
4	PG009	720x540	600	300	300	50
	PG012	720x540	600	300	300	50
5	PG016	480x360	600	300	300	50
	PG017	720x540	600	300	300	50
All Videos			6000	3000	3000	500

2 Quantitative comparison on individual folds using laparoscopic images dataset

Table 2 Quantitative comparison on the organized clear and hazy images dataset in **Fold 1**. Mean and standard deviation of the four metrics is reported. Lower values of FADE is better. Higher value of JNGM and REA are better.

	FADE		JNBM		REA	
	clear	hazy	clear	hazy	clear	hazy
Input	0.35±0.14	0.79±0.52	1.06±0.21	1.15±0.26	0.00	0.00
CycleGAN [1]	0.38±0.12	0.44±0.15	0.96±0.18	1.08±0.20	0.95±0.07	1.30±0.32
FastCUT [2]	0.58±0.17	0.80±0.20	1.20±0.24	1.07±0.21	4.78±1.70	5.40±1.91
GAN-DC [3]	0.30±0.08	0.36±0.10	1.23±0.21	1.15±0.22	1.10±0.06	3.02±1.26
Cycle-Dehaze [4]	0.30±0.16	0.28±0.02	2.13±0.39	2.08±0.16	1.40±0.40	1.46±0.35
IC only	0.38±0.12	0.47±0.21	0.96±0.19	1.07±0.20	0.98±0.10	1.27±0.31
DC only	0.37±0.12	0.47±0.22	0.93±0.18	1.07±0.22	0.98±0.11	1.27±0.33
Proposed	0.36±0.11	0.47±0.20	0.96±0.17	1.06±0.20	1.01±0.12	1.28±0.29

Table 3 Quantitative comparison on the organized clear and hazy images dataset in **Fold 2**. Mean and standard deviation of the four metrics is reported. Lower values of FADE is better. Higher value of JNGM and REA are better.

	FADE		JNBM		REA	
	clear	hazy	clear	hazy	clear	hazy
Input	0.44±0.16	0.81±0.52	1.04±0.35	0.93±0.26	0.00	0.00
CycleGAN [1]	0.42±0.13	0.43±0.12	0.99±0.26	0.97±0.26	1.06±0.13	1.42±0.38
FastCUT [2]	0.70±0.34	0.98±0.38	1.05±0.31	1.02±0.25	1.05±0.22	1.13±0.21
Colores et al. [3]	0.35±0.09	0.42±0.12	1.23±0.34	1.10±0.28	1.79±0.59	2.48±0.72
Cycle-Dehaze [4]	0.28±0.03	0.28±0.02	2.13±0.20	2.13±0.19	1.97±0.60	1.94±0.60
IC only	0.42±0.14	0.43±0.12	0.94±0.28	0.95±0.26	1.04±0.16	1.31±0.32
DC only	0.43±0.13	0.43±0.12	0.94±0.25	0.95±0.25	1.04±0.15	1.34±0.31
Proposed	0.43±0.13	0.41±0.13	0.97±0.26	0.95±0.26	1.05±0.17	1.40±0.41

Table 4 Quantitative comparison on the organized clear and hazy images dataset in **Fold 3**. Mean and standard deviation of the four metrics is reported. Lower values of FADE is better. Higher value of JNGM and REA are better.

	FADE		JNBM		REA	
	clear	hazy	clear	hazy	clear	hazy
Input	0.42±0.13	0.94±0.69	1.29±0.22	1.25±0.27	0.00	0.00
CycleGAN [1]	0.42±0.11	0.42±0.18	1.13±0.21	1.16±0.20	0.89±0.03	1.35±0.44
FastCUT [2]	0.53±0.24	0.79±0.23	1.26±0.23	1.21±0.22	1.00±0.31	1.22±0.31
Colores et al. [3]	0.32±0.07	0.43±0.13	1.38±0.23	1.26±0.23	1.81±0.57	3.00±0.46
Cycle-Dehaze [4]	0.28±0.02	0.28±0.02	2.07±0.16	2.08±0.16	1.61±0.52	1.57±0.42
IC only	0.35±0.08	0.39±0.17	1.13±0.20	1.16±0.21	1.13±0.14	1.55±0.36
DC only	0.37±0.09	0.38±0.18	1.16±0.22	1.21±0.22	1.11±0.12	1.56±0.45
Proposed	0.37±0.09	0.39±0.17	1.10±0.20	1.17±0.20	1.10±0.13	1.53±0.38

4 *DeSmoke-LAP***Table 5** Quantitative comparison on the organized clear and hazy images dataset in **Fold 4**. Mean and standard deviation of the four metrics is reported. Lower values of FADE is better. Higher value of JNGM and REA are better.

	FADE		JNBM		REA	
	clear	hazy	clear	hazy	clear	hazy
Input	0.49±0.17	1.07±0.50	1.12±0.26	1.22±0.33	0.00	0.00
CycleGAN [1]	0.47±0.16	0.47±0.17	1.03±0.23	1.12±0.26	1.00±0.13	1.50±0.47
FastCUT [2]	0.69±0.23	0.86±0.19	1.19±0.28	1.17±0.27	1.22±0.27	1.31±0.33
Colores et al. [3]	0.34±0.08	0.46±0.13	1.27±0.25	1.20±0.27	2.03±0.32	3.47±0.22
Cycle-Dehaze [4]	0.32±0.16	0.35±0.30	2.25±0.50	2.27±0.65	1.80±0.41	1.95±0.57
IC only	0.41±0.12	0.41±0.14	1.01±0.21	1.08±0.23	1.10±0.14	1.54±0.33
DC only	0.41±0.12	0.40±0.14	1.01±0.21	1.09±0.23	1.07±0.13	1.54±0.35
Proposed	0.38±0.11	0.38±0.13	1.08±0.21	1.15±0.23	1.15±0.16	1.62±0.32

Table 6 Quantitative comparison on the organized clear and hazy images dataset in **Fold 5**. Mean and standard deviation of the four metrics is reported. Lower values of FADE is better. Higher value of JNGM and REA are better.

	FADE		JNBM		REA	
	clear	hazy	clear	hazy	clear	hazy
Input	0.36±0.12	0.63±0.40	1.06±0.23	1.11±0.31	0.00	0.00
CycleGAN [1]	0.37±0.11	0.37±0.14	1.01±0.21	1.10±0.24	0.87±0.45	1.45±0.45
FastCUT [2]	0.47±0.18	0.63±0.23	1.09±0.24	1.11±0.28	1.09±0.41	1.22±0.39
Colores et al. [3]	0.29±0.07	0.35±0.10	1.28±0.31	1.21±0.28	1.93±0.49	3.33±0.37
Cycle-Dehaze [4]	0.26±0.03	0.27±0.02	2.02±0.17	2.08±0.17	1.59±0.57	1.70±0.54
IC only	0.37±0.10	0.40±0.17	0.98±0.20	1.07±0.25	1.03±0.14	1.33±0.31
DC only	0.36±0.10	0.39±0.17	1.01±0.21	1.10±0.27	1.05±0.15	1.33±0.31
Proposed	0.36±0.10	0.39±0.16	1.01±0.21	1.10±0.25	1.05±0.16	1.34±0.29

3 Quantitative results for individual folds on video clips

Table 7 Quantitative comparison on the the video clips in **Fold 1**. Mean and standard deviation of the four metrics are reported. Lower values of FADE is better. Higher values of JNGM and REA are better.

	FADE	JNBM	REA
Input	0.89±0.69	2.85±1.13	0.00
CycleGAN [1]	0.46±0.18	1.07±0.18	1.20±0.31
FastCUT [2]	0.75±0.20	1.12±0.18	0.95±0.18
Colores et al. [3]	0.36±0.11	1.19±0.18	5.28±1.75
Cycle-Dehaze [4]	0.28±0.02	2.05±0.15	1.60±0.37
IC only	0.46±0.20	1.09±0.20	1.22±0.31
DC only	0.48±0.21	1.06±0.19	1.19±0.29
Proposed	0.46±0.18	1.06±0.16	1.19±0.26

Table 8 Quantitative comparison on the the video clips in **Fold 2**. Mean and standard deviation of the four metrics are reported. Lower values of FADE is better. Higher values of JNGM and REA are better.

	FADE	JNBM	REA
Input	1.03±0.40	2.77±0.38	0.00
CycleGAN [1]	0.42±0.11	0.85±0.17	1.13±0.21
FastCUT [2]	0.64±0.17	0.98±0.24	1.02±0.18
Colores et al. [3]	0.33±0.11	1.01±0.26	5.29±1.66
Cycle-Dehaze [4]	0.28±0.08	2.01±0.24	1.51±0.41
IC only	0.42±0.12	0.87±0.20	1.12±0.26
DC only	0.40±0.11	0.86±0.18	1.15±0.21
Proposed	0.40±0.11	0.91±0.19	1.15±0.25

Table 9 Quantitative comparison on the the video clips in **Fold 3**. Mean and standard deviation of the four metrics are reported. Lower values of FADE is better. Higher values of JNGM and REA are better.

	FADE	JNBM	REA
Input	1.35±0.93	3.89±1.28	0.00
CycleGAN [1]	0.32±0.14	1.17±0.21	1.51±0.42
FastCUT [2]	0.59±0.25	1.24±0.27	1.09±0.25
Colores et al. [3]	0.35±0.13	1.26±0.29	4.03±1.11
Cycle-Dehaze [4]	0.27±0.03	2.06±0.19	1.19±0.28
IC only	0.32±0.14	1.18±0.27	1.47±0.43
DC only	0.40±0.10	1.17±0.24	1.47±0.44
Proposed	0.32±0.13	1.16±0.24	1.41±0.34

6 *DeSmoke-LAP***Table 10** Quantitative comparison on the the video clips in **Fold 4**. Mean and standard deviation of the four metrics are reported. Lower values of FADE is better. Higher values of JNGM and REA are better.

	FADE	JNBM	REA
Input	1.93±0.58	3.65±0.47	0.00
CycleGAN [1]	0.56±0.11	1.05±0.14	1.36±0.36
FastCUT [2]	0.84±0.11	1.10±0.18	1.22±0.15
Colores et al. [3]	0.51±0.08	1.08±0.13	6.80±1.75
Cycle-Dehaze [4]	0.29±0.02	2.03±0.12	2.20±0.35
IC only	0.43±0.11	1.00±0.15	1.48±0.37
DC only	0.39±0.10	1.04±0.16	1.47±0.43
Proposed	0.38±0.07	1.07±0.13	1.61±0.29

Table 11 Quantitative comparison on the the video clips in **Fold 5**. Mean and standard deviation of the four metrics are reported. Lower values of FADE is better. Higher values of JNGM and REA are better.

	FADE	JNBM	REA
Input	0.68±0.30	2.71±0.83	0.00
CycleGAN [1]	0.30±0.08	1.27±0.20	1.41±0.23
FastCUT [2]	0.54±0.09	1.28±0.20	1.03±0.12
Colores et al. [3]	0.30±0.04	1.36±0.19	5.72±1.86
Cycle-Dehaze [4]	0.28±0.07	2.10±0.21	1.45±0.15
IC only	0.31±0.07	1.18±0.19	1.25±0.25
DC only	0.30±0.08	1.28±0.22	1.38±0.20
Proposed	0.30±0.07	1.25±0.21	1.44±0.26

4 Qualitative comparison using images dataset

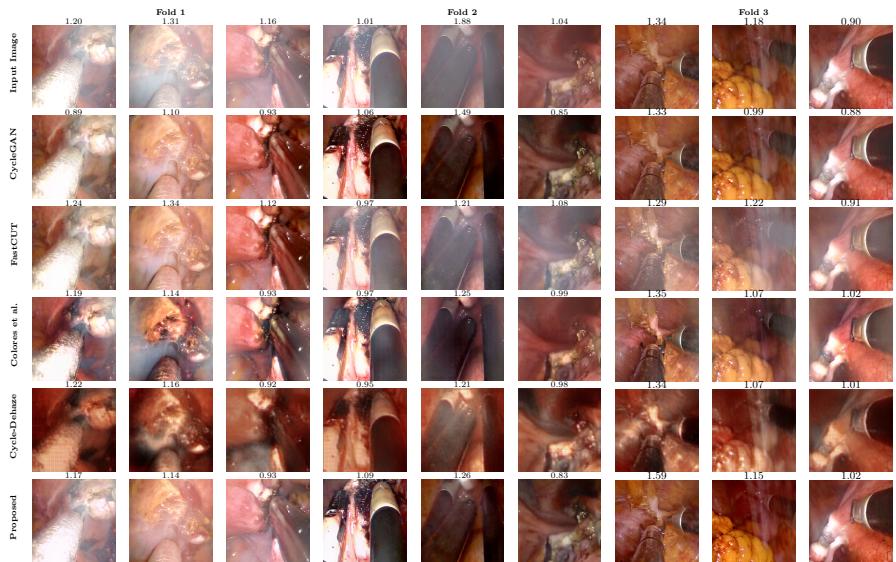


Fig. 1 Comparison with the proposed method in image data (Fold 1-3), samples are selected from each fold containing images with light, medium, heavy smoke.



Fig. 2 Comparison with the proposed method in image data (Fold 4-5), samples are selected from each fold containing images with light, medium, heavy smoke.

References

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