Variational based smoke removal in laparoscopic images

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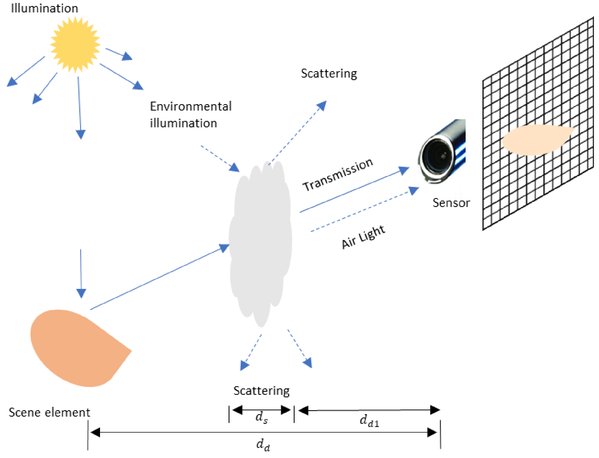
INTRODUCTION

Aim:
Remove smoke in laparoscopic images using an image preprocessing method based on a variational approach.

METHOD

- Physical model of smoke image acquisition

$$I = L + F = J_s t_s + A_s(1 - t_s)$$



METHOD

Degradation model:

$$I = L + F = J_s t_s + A_s(1 - t_s)$$

1. Smoke veil F estimation based on smoke component's prior:

- Smoke has a low contrast
- Smoke has low inter-channel differences

$$E = \frac{\lambda}{2} \| F - I \|^2 + \| F_{TV} \|_2$$

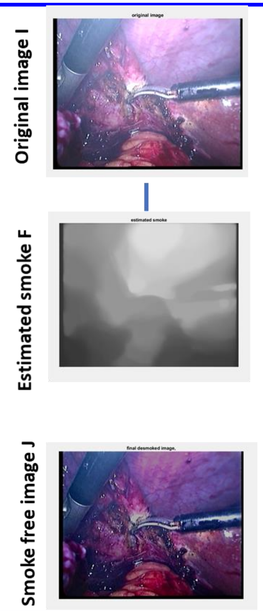
where $$\| F_{TV} \|_2 = \sum \sqrt{\beta_x^2 [D_x F]_i^2 + \beta_y^2 [D_y F]_i^2 + \beta_c^2 [D_c F]_i^2}$$

2. *Direct attenuation* L is computed by

$$L = I - \alpha \bullet F$$

3. Smoke free image J_s is obtained by

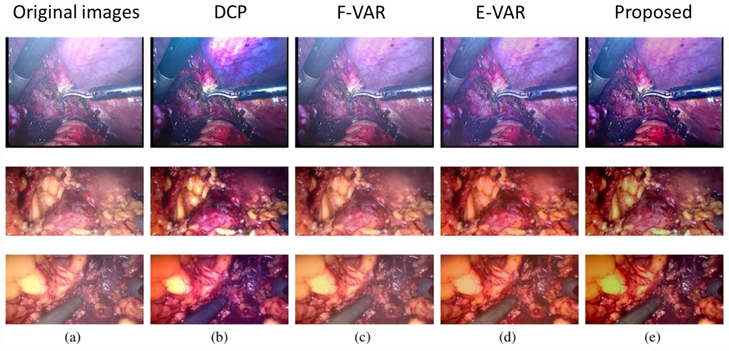
- linearly map the R, G, B channels' values of L to (0, 255)



CONCLUSION

- The proposed approach reduces the smoke effectively while preserving the important perceptual information of the image.
- Computational speed is limited by the global method.

RESULTS



	Dataset1				Dataset2			
	FADE [42]	JNBM [44]	RE [45]	MICM [46]	FADE [42]	JNBM [44]	RE [45]	MICM [46]
Input images	0.40	1.42	NA	2.62	0.67	1.03	NA	2.85
DCP [17]	0.27	1.57	0.38	2.28	0.33	1.06	0.88	2.72
F-VAR [28]	0.43	1.62	0.12	2.50	0.50	1.09	0.41	2.63
E-VAR [27]	0.35	1.50	0.24	2.13	0.36	1.05	0.73	2.50
Proposed	0.23	1.77	0.39	2.02	0.30	1.16	1.19	2.40