Polarimetric Camera Calibration Using an LCD Monitor

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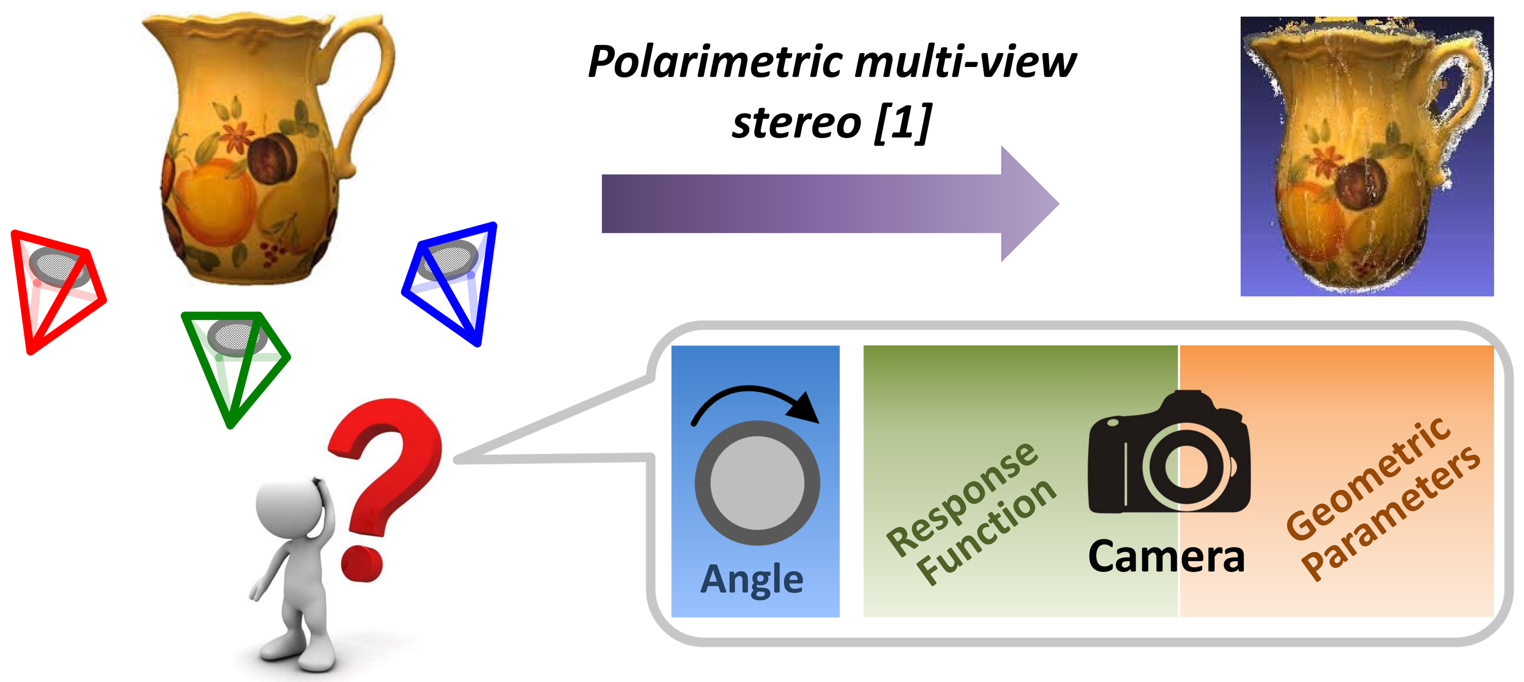
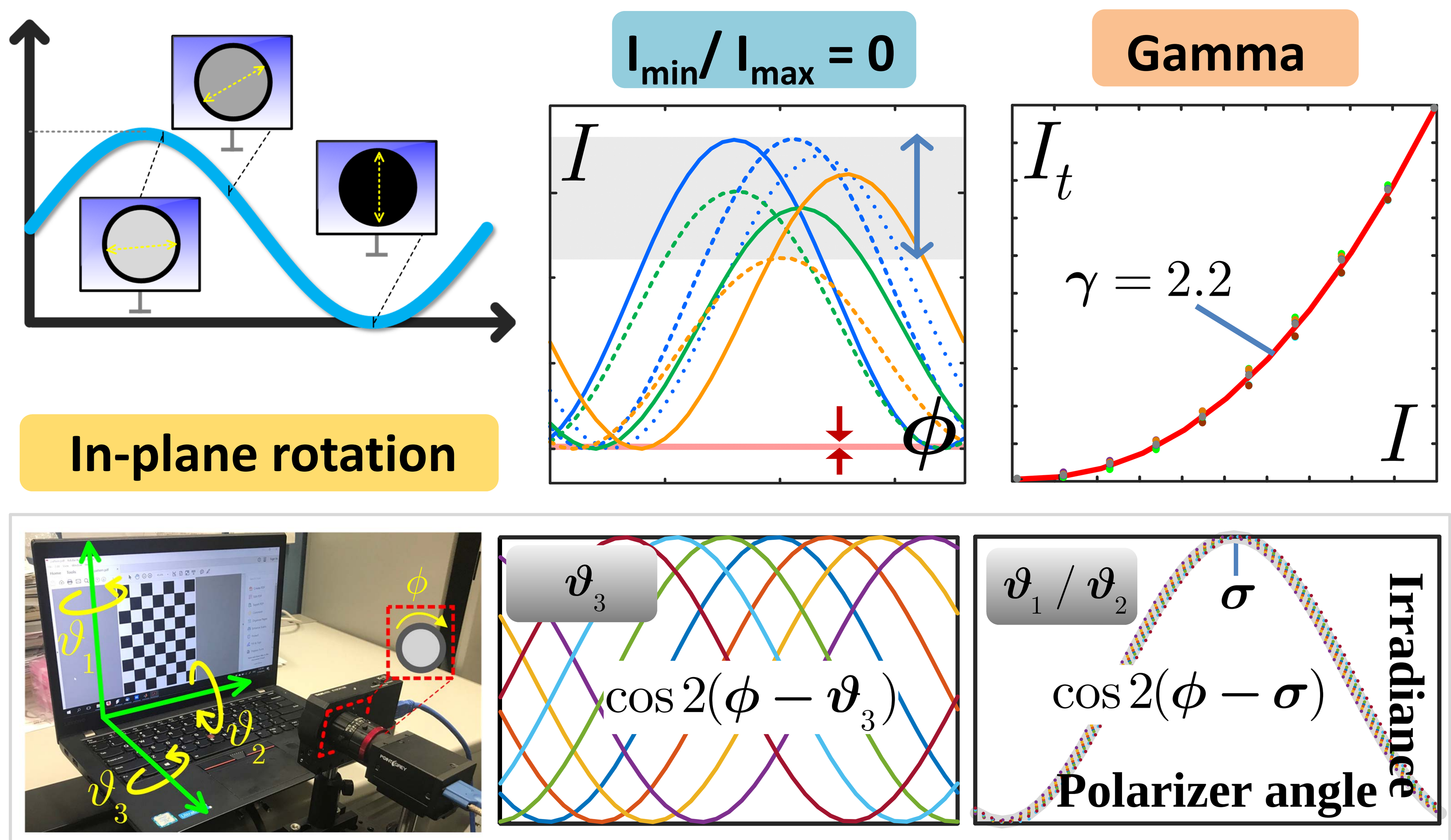
1. Introduction



	Self-Calib?	Reliable?	Suit w/ 3 polar. channels?	Robust to nonlinear CRF?	CRF?	Geometric parameters?
[2]	✓	✗	✗	✗	✗	✗
[3]	✓	✗	✗	✗	✓	✗
Ours	✗	✓	✓	✓	✓	✓

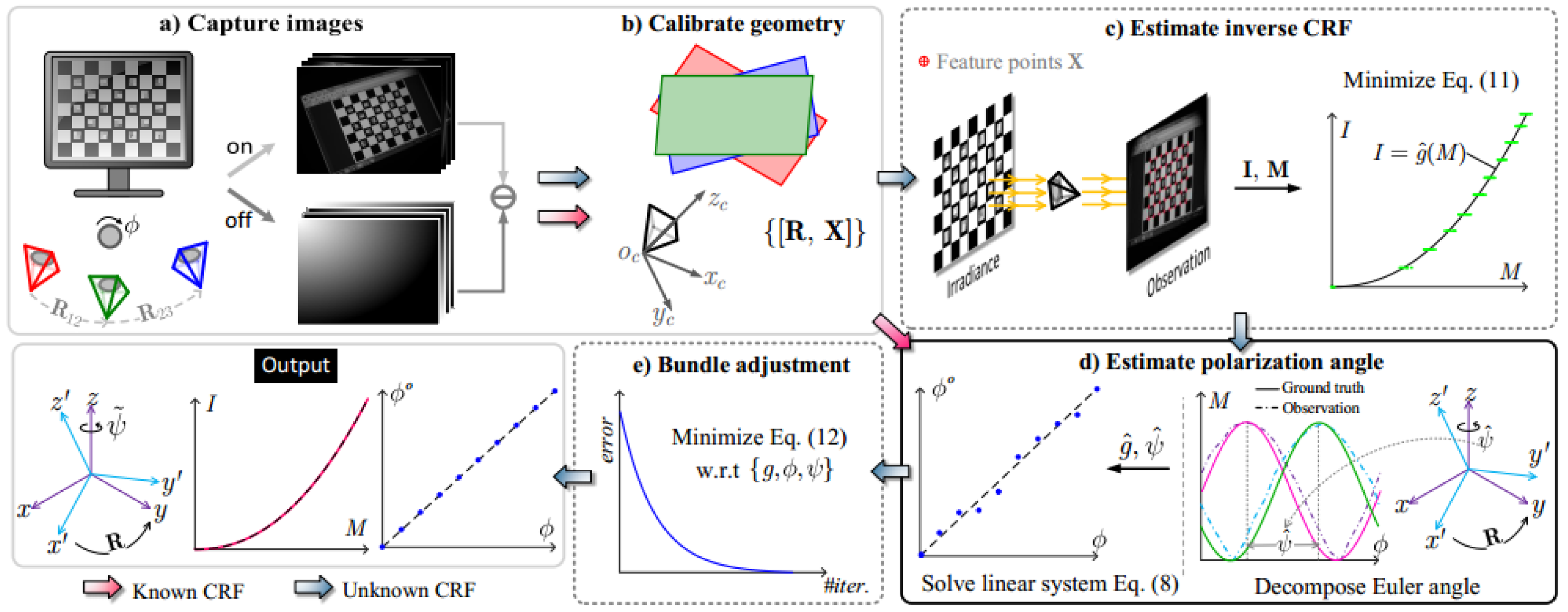
2. Characteristics of LCD Monitors



References

[1] Z. Cui, J. Gu, B. Shi, P. Tan, and J. Kautz. Polarimetric multi-view stereo. In *CVPR*, 2017.
[2] Y. Y. Schechner. Self-calibrating imaging polarimetry. In *ICCP*, 2015.
[3] D. Teo, B. Shi, Y. Zheng, and S.-K. Yeung. Self-calibrating polarising radiometric calibration. In *CVPR*, 2018.

3. Method



a. Known Inverse CRF

a) ⇒ b) ⇒ d)

$$\hat{g}(M_{k,p}) = t_p + a_p \cos 2(\phi_k - \hat{\psi}_p)$$

$I_{\min} \approx 0$

$$\frac{\hat{g}(M_{k,p})}{\hat{g}(M_{1,p})} = \frac{1 + \alpha_p \cos 2\phi_k + \beta_p \sin 2\phi_k}{1 + \alpha_p \cos 2\phi_1 + \beta_p \sin 2\phi_1}$$

$$\widetilde{\mathbf{P}} = \left(\widetilde{\mathbf{O}}^T \widetilde{\mathbf{O}}\right)^{-1} \widetilde{\mathbf{O}}^T \widetilde{\mathbf{D}}$$

d) Linear Method

b. Unknown Inverse CRF

a) ⇒ b) ⇒ c) ⇒ d) ⇒ e)

$$I = g(M) = \sum_{n=0}^{N} c_n M^n$$

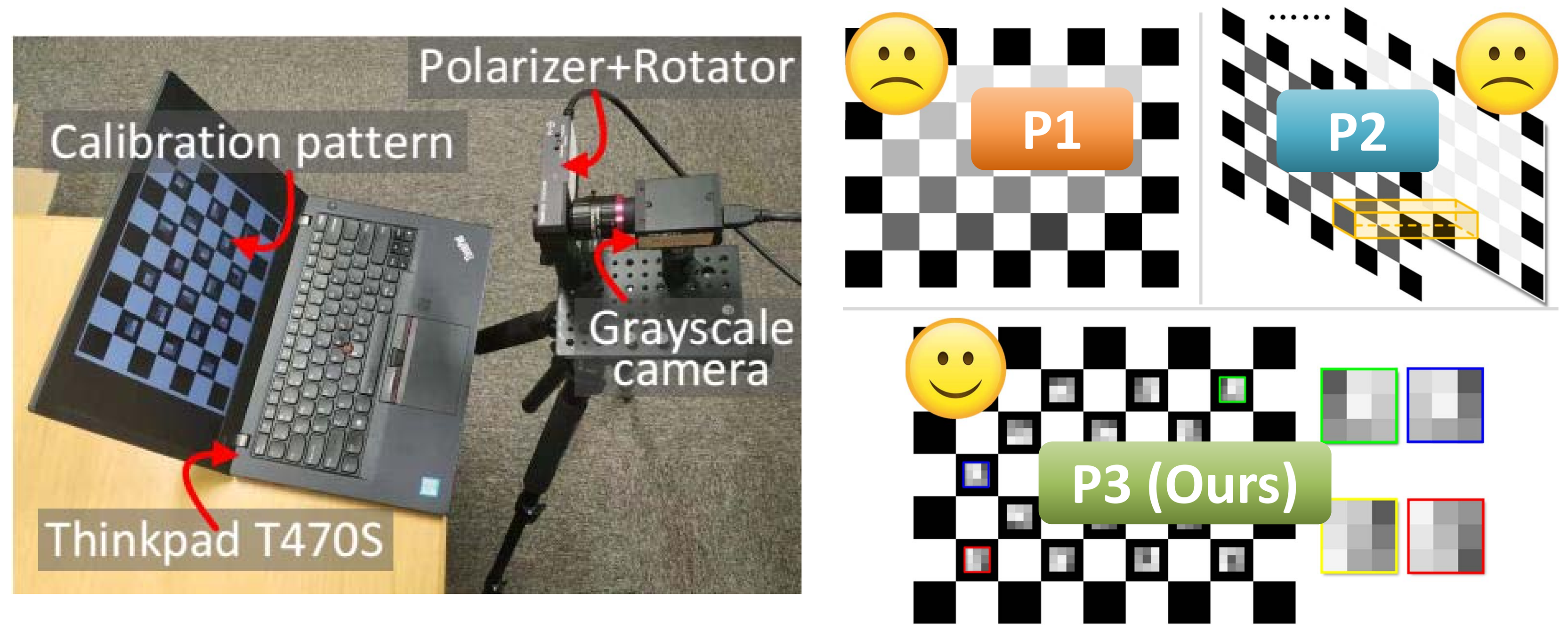
$$\hat{g} = \operatorname{argmin}_{g \in \mathcal{W}} \|\mathbf{I} - g(\mathbf{M})\|^2 + \lambda \left| \frac{\partial^2 g}{\partial M^2} \right|$$

c) Estimate CRF

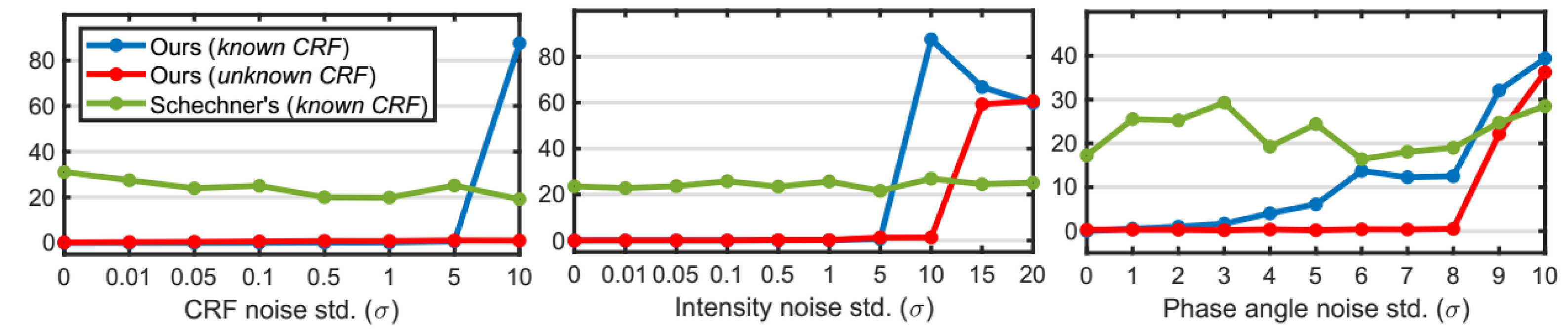
$$\sum_{k=1}^{K} \sum_{p=1}^{P} \|t_p\big(c(2\phi_k)c(2\psi_p) + s(2\phi_k)s(2\psi_p) + 1\big) - g(M_{k,p})\|^2$$

e) Bundle adjustment

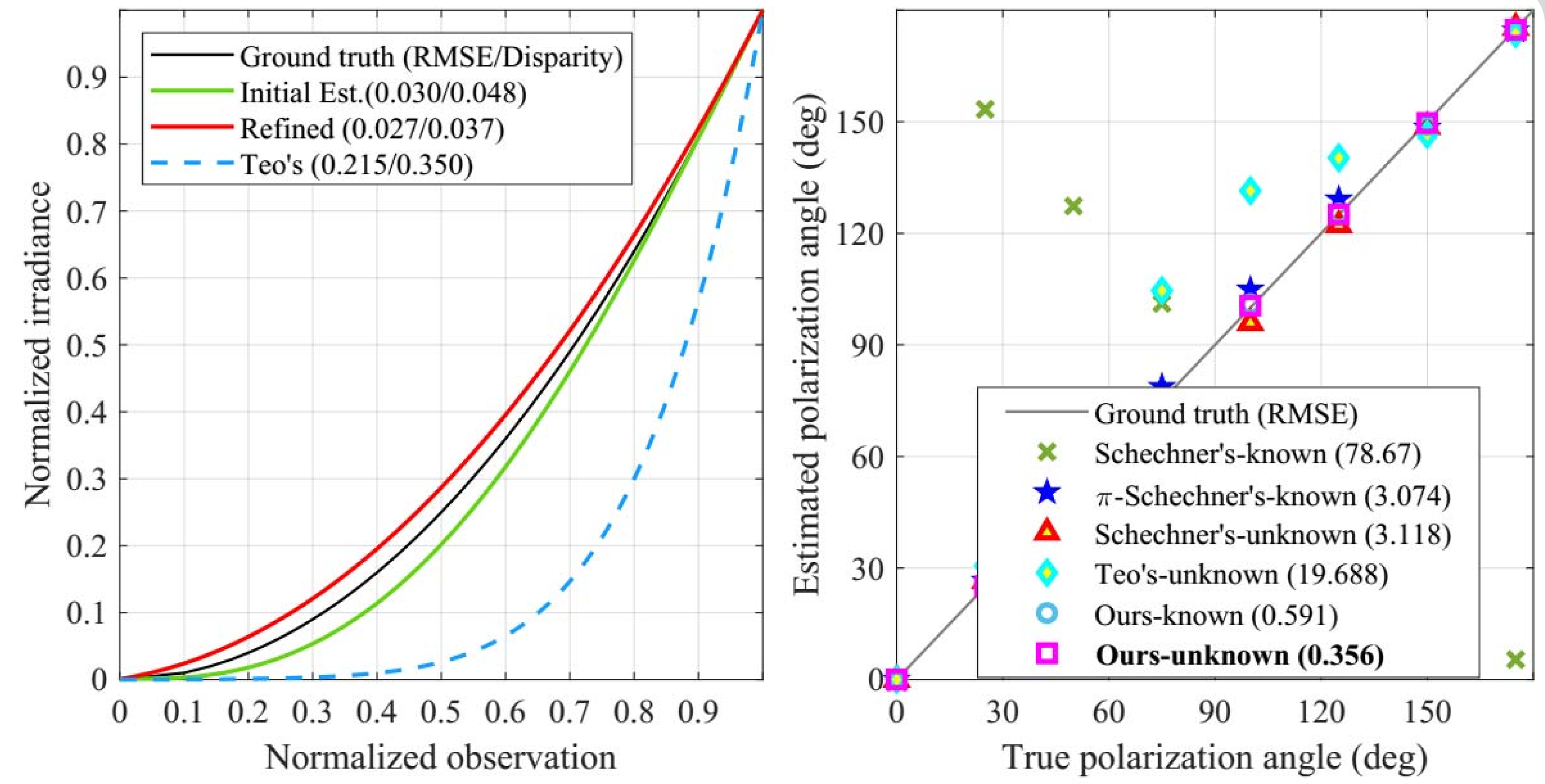
4. Experiments



a. Simulation (sensitivity analysis)



b. Real-world Experiments (comparison)



CRF	Method	CRF err.	Ang. err.	#polar. ang.	#images
known	[32]	✗	8.85±15.39	≥4	≥4
	Ours	✗	**0.62±0.28**	**≥2**	≥4
unknown	[32] + ICRF	✗	15.84±29.59	≥4	≥4+11
	[36]	0.13±0.09	12.56±7.31	≥4	≥4
	Ours	**0.04±0.02**	**0.63±0.18**	**≥2**	≥4

5. LCDs' suitability