Quality-Improved and Property-Preserved Polarimetric Imaging via Complementarily Fusing

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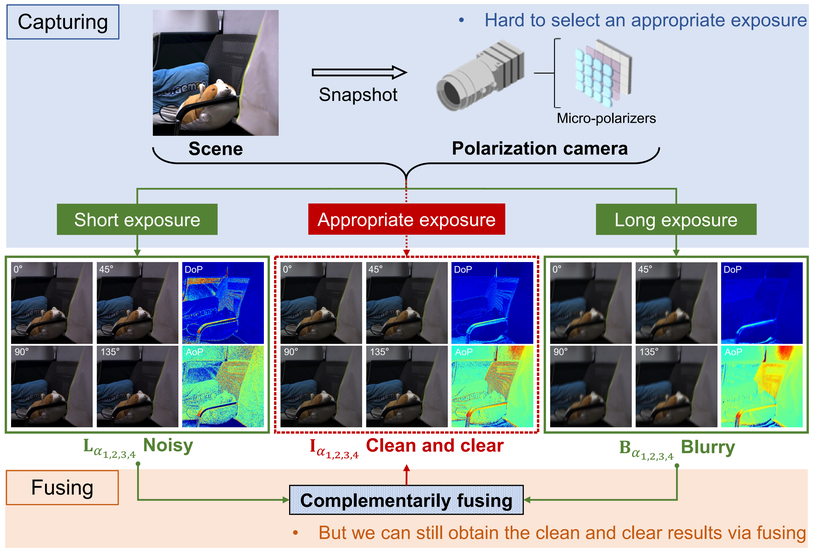
Contributions

- A quality-improved and property-preserved polarimetric imaging framework
  - for the first time applying a fusing strategy to polarimetric imaging.
- A neural network-based three-phase fusing scheme
  - utilizing the complementary knowledge in a polarization-aware manner.
- Specially-designed modules tailored to each phase
  - effectively exploring the usage of different physical quantities.

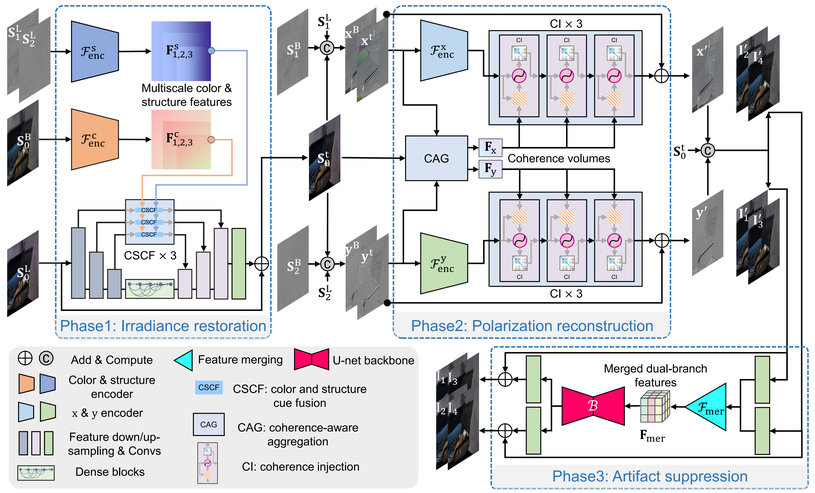
Background & Motivation



- A polarization camera can capture four polarized images with different polarizer angles $\alpha_{1,2,3,4} = 0°, 45°, 90°, 135°$ in a snapshot.
  - The degree of polarization (DoP) and angle of polarization (AoP) can be calculated from the captured polarized images, providing physical clues for downstream polarization-based vision applications.
- It's hard to select an appropriate exposure time.
  - An inappropriate exposure time would lead to low-quality DoP and AoP.
- But different types of degradation could provide complementary knowledge:
  - short-exposure ones tend to be noisy but clear.
  - long-exposure ones tend to be blurry but clean.

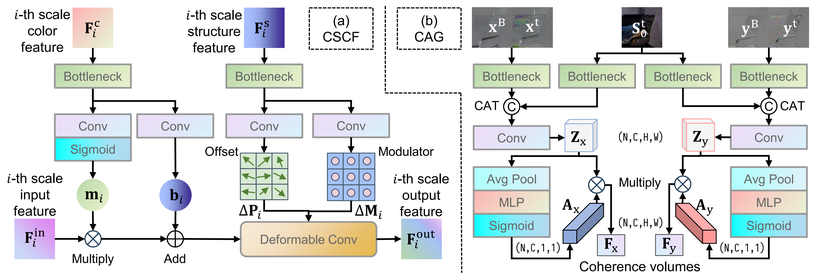
Method

Neural network-based three-phase fusing scheme



- Irradiance restoration: for restoring the polarization-unrelated high-level irradiance information for providing further guidance.
- Polarization reconstruction: for establishing the physical correlation between the polarized images by reconstructing the high-quality DoP and AoP.
- Artifact suppression: for increasing the quality of details by suppressing the artifacts in the image domain.

Specially-designed modules



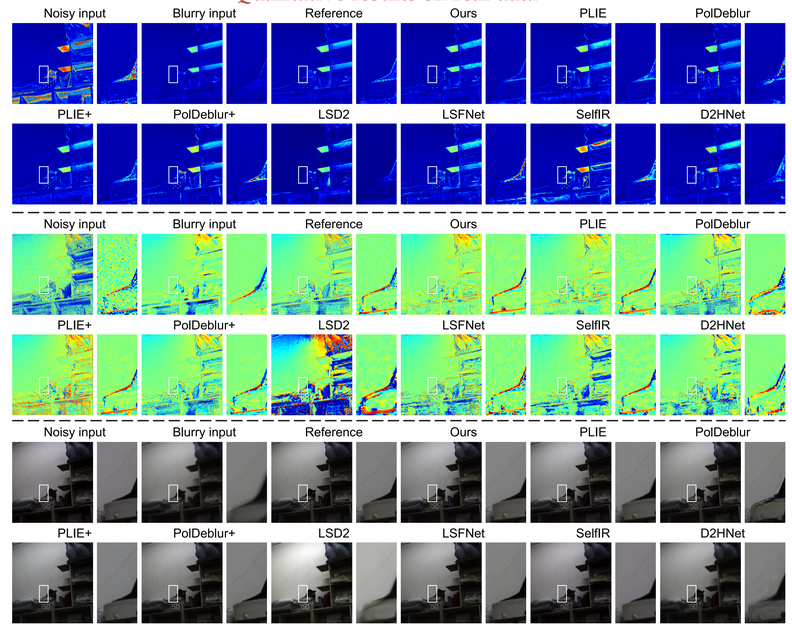
- CSCF (color and structure cue fusion): aiming to address the issues of erroneous global tone and less salient local structure in the feature space.
- CAG (coherence-aware aggregation): aiming to establish the physical correlation between the polarized images by reconstructing the high-quality DoP and AoP in a Cartesian coordinate representation.

Experiments

Quantitative results on synthetic data

	PSNR-**p**	SSIM-**p**	PSNR-θ	SSIM-θ	PSNR-$\mathbf{S}_0$	SSIM-$\mathbf{S}_0$
Ours	**29.23**	**0.797**	**16.96**	**0.382**	**39.05**	**0.982**
PLIE	27.91	0.790	15.92	0.371	38.95	0.978
PLIE+	27.98	0.794	16.93	0.379	39.01	0.979
PolDeblur	24.52	0.676	15.73	0.280	26.12	0.794
PolDeblur+	25.31	0.758	16.75	0.374	39.04	0.981
LSD2	25.73	0.662	13.75	0.288	27.88	0.905
LSFNet	25.56	0.693	15.90	0.282	26.76	0.826
SelfIR	19.43	0.647	15.39	0.231	25.90	0.785
D2HNet	24.45	0.671	15.63	0.264	25.25	0.803

Qualitative results on real data



Downstream polarization-based vision application: reflection removal