A Processing Pipeline for Low-Light Burst Images

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Motivation and Goals

- **Motivation:** : Phone cameras are becoming increasingly sophisticated, but they still suffer in conditions of low light. We propose to combine information from multiple 'burst' images taken in low-light situations.

- **Goals:**
  - Avoid blurring with low exposure bursts
  - Merge multiple burst photos to a single sharp image
  - Denoise merged image
  - Enhance illumination and contrast

Image Registration

- **Registration:** The burst images must first be aligned to a single image, weighted, and merged. Denoising was then tested with NLM and BM3d (BM3d results shown below).


Sharpest single image


Simple addition


Global shift


Pixel-by-pixel shift


Collaborative NLM


Patch-based alignment


Feature-based alignment

Results (BM3d-filtered image)		
Method	**PSNR**	**Blur**
Reference image	18.37	8.53
Simple addition	19.38	5.92
Global shift	18.62	6.69
Pixel-by-pixel shift	18.50	5.23
Collaborative NLM	18.18	8.53
Patch-based alignment	18.23	8.56
Feature-based alignment	18.95	8.89

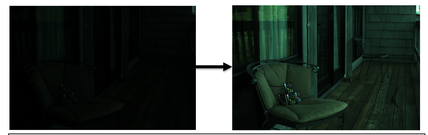
Image Enhancement

- **Low-Light Image Enhancement:** Recovers enhanced low-light image by estimating illumination map.

- **Exposure fusion:** Artificially create an LDR image by fusing the light-enhanced image with the original image.

- **De-hazing:** Reduces the effect of veiling glare

- **Global tone mapping:** Increase contrast by applying a set gamma correction to the entire image



Low-Light Image Enhancement:	
Lightness Order Error (LOE)	0.03



Exposure Fusion		
Tenengrad Meas. (quality/sharpness)	**Original**	**HDR fuse**
	0.16	0.19



De-hazing		
Tenengrad Meas. (quality/sharpness)	**Original**	**Dehazed**
	0.06	0.11

Processing Pipeline

Burst Images → Align & Merge → Denoise → Light-Enhance → HDR fusion → Dehaze → Global Tone Map



























