Digital Photography with Flash No Flash Image Pairs

(CS663 Course Project)

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Content

- Denoising and Detail transfer
  - Bilateral filter
  - Joint Bilateral filter
- Flash to Ambient detail transfer
- Detecting Flash Shadows and Specularities
- White balancing
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Denoising and detail transfer

Bilateral filter

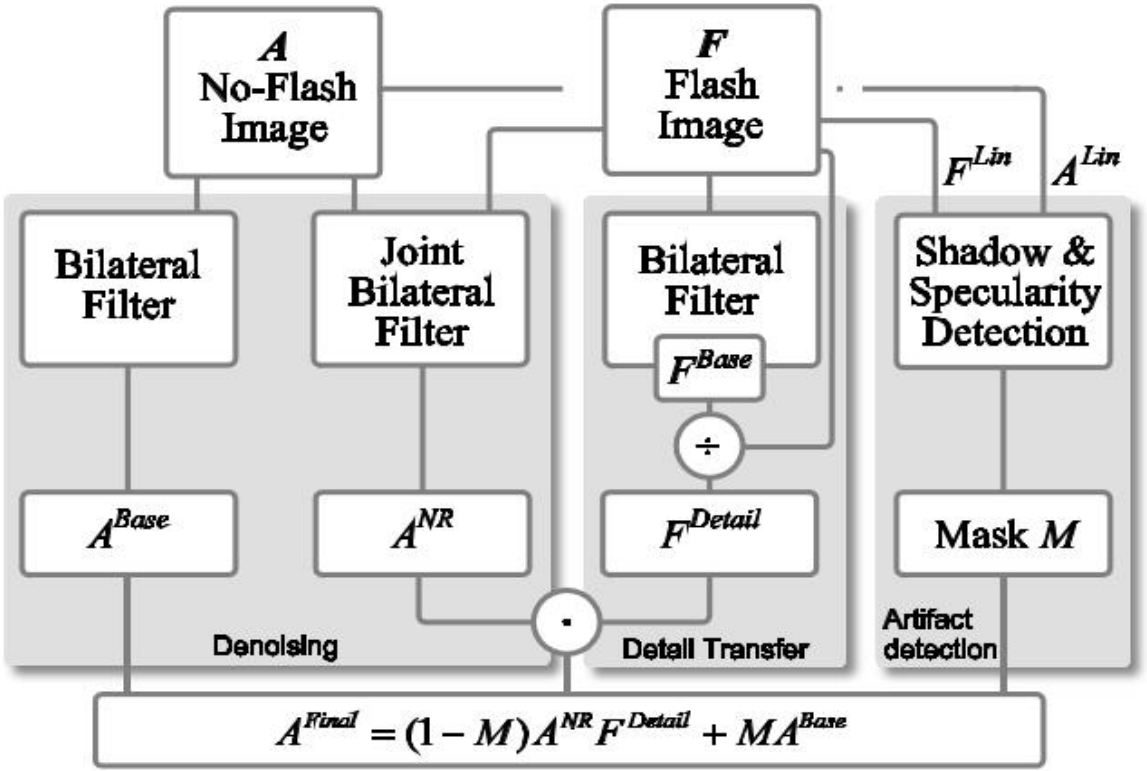
$$A_p^{Base} = \frac{1}{k(p)} \sum_{p' \in \Omega} g_d(p' - p)\, g_r\left(A_p - A_{p'}\right) A_{p'},$$

$$k(p) = \sum_{p' \in \Omega} g_d(p' - p)\, g_r\left(A_p - A_{p'}\right).$$

Joint Bilateral filter

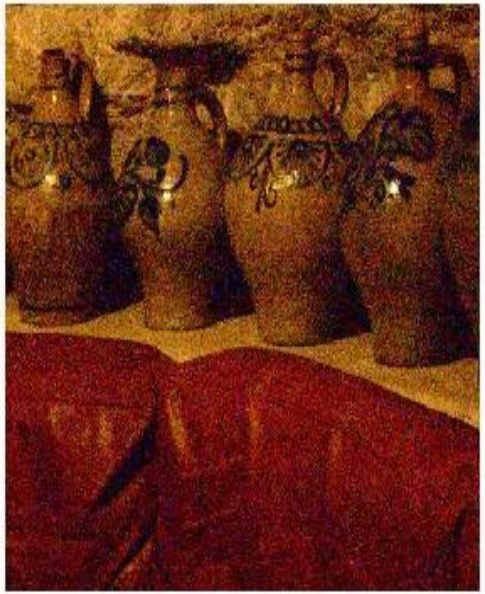
$$A_p^{NR} = \frac{1}{k(p)} \sum_{p' \in \Omega} g_d(p' - p)\, g_r\left(F_p - F_{p'}\right) A_{p'}$$

Block Diagram



Detail transfer

NF



FI

A_{Final}

Detail transfer

NF

FI

Final

Flash to Ambient detail transfer

$$F^{Detail} = \frac{F + \varepsilon}{F^{Base} + \varepsilon},$$

- F denotes the flash image
- FBase denotes the bilateral filter output on image F
- Epsilon is some constant

Detail Transfer

NF

FI

A_{Final}

Flash adjustment between the Afinal and Im_flash

$Flash_a$dj alpha=0.8

$Flash_a$dj alpha=0.5

$Flash_a$dj alpha=0.3

Shadow and spec Mask calc

Mask_Shadow =

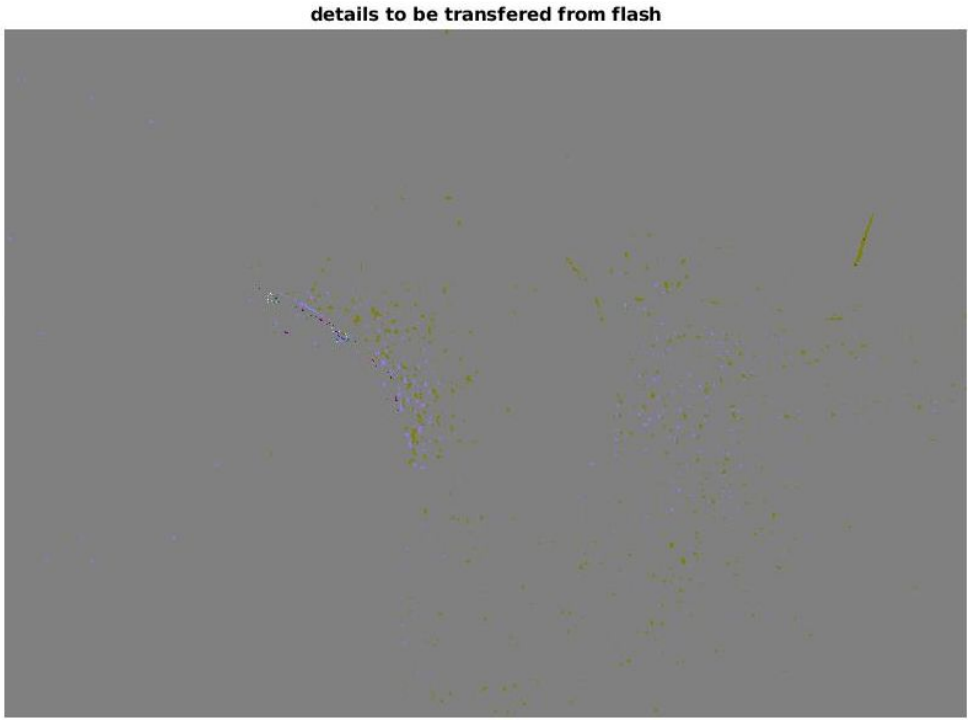
$$M^{Shad} = \begin{cases} 1 \text{ when } F^{Lin} - A^{Lin} \leq \tau_{Shad} \\ 0 \text{ otherwise.} \end{cases}$$

Mask_spec = linF >= 0.95 .* (max(max(linF)) - min(min(linF)))

Mask_total = M_Shadow ∪ M_Specularity

Details to be transfered

Detected Flash and shadow specularities



White Balancing

- Illumination due to flash $\Delta = F^{Lin} - A^{Lin}$
- Computation performed per color channel
- Estimated color Cp =(Ap/Delta_p)
- Ignoring the Ambient pixel values less than thr1 or the luminescence thr2
- Averaging the estimated color value over non-discarded pixels of each color
- Finally white balanced Ambient image is calculated by scaling the color channel

White Balance

Flash$_{original}$

Ambient$_{original}$ Light$_{orange}$

estimateambient illuminant

White Balanced image

Red eye correction

- Relative Redness measure R = Fcr - Acr
- We then initially segment the image into regions where: $R > \tau\_Eye$. (Here on whole image)
- R > max[0.6, $\mu R + 3\sigma R$] and Ay < τ_Dark (Ay Luminance)
- After detection of red region we perform dot wise image multiplication with the mask
- Finally we perform the red eye correction.

Red eye removal

Pixel info: (X, Y) Pixel Value

Thank you