Digital Photography with Flash and No-Flash Image Pairs

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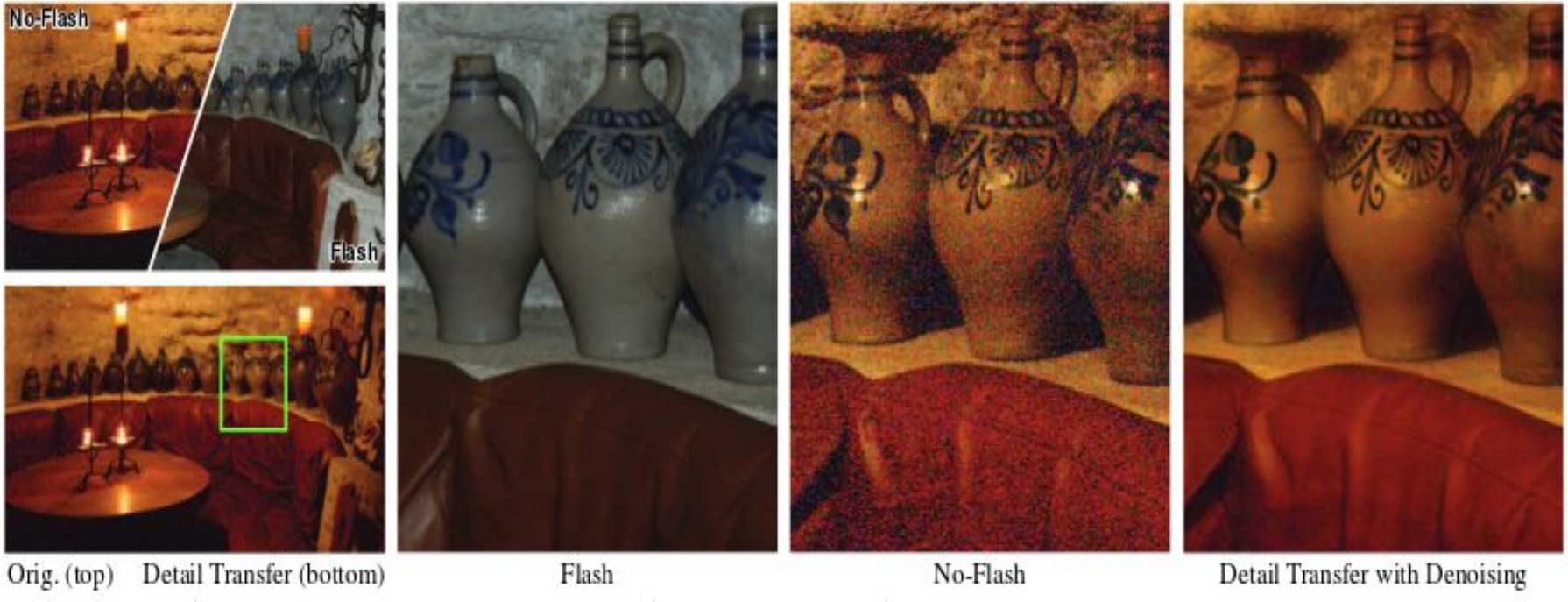
We present a variety of applications that analyze and combine the strengths of such flash/no-flash image pairs. Our applications include denoising and detail transfer (to merge the ambient qualities of the no-flash image with the high-frequency flash detail), white-balancing (to change the color tone of the ambient image), continuous flash (to interactively adjust flash intensity), and red-eye removal (to repair artifacts in the flash image). We demonstrate how these applications can synthesize new images that are of higher quality than either of the originals

Enhancement Model

Denoising and detail transfer
White-balancing
Continuous Flash Adjustment
Red-eye removal



Denoising and detail transfer

➔ to merge the ambient qualities of the no-flash image with the high-frequency flash detail

The ambient image denoising technique builds on a bilateral filter. But the basic bilateral filter tends to either over-blur (lose detail) or under-blur (fail to denoise) the image in some regions. The flash image contains a much better estimate of the true high-frequency information than the ambient image. Based on this observation, we modify the basic bilateral filter into a joint bilateral filter. The values of variance for the filters are automatically computed by our algorithm depending on the image.

We then detect flash shadows and specularities in the flash image and then use that mask to improve our result from the joint bilateral filter.

Also to pass over more details from the flash image to the ambient image, we obtain the details from the flash image using a basic bilateral filter on the flash image and then dividing the original by the filtered image to get the detailed layer, furthermore to enhance the details we add the laplacian of the flash image too.

Denoising and detail transfer

Flash Image

No-Flash Image

Denoising and detail transfer

Detail Transfer

Enhanced Image

Denoising and detail transfer

No-Flash Image

Enhanced Image

Denoising and detail transfer

Result in paper followed

Our Result

White Balancing

➔ to change the color tone of the ambient image

Sometimes the viewer wants to see the image under a more ‘illuminant’ setting, for that we perform white balancing.

We can think of the flash as adding a point light source of known color to the scene. The difference image between luminance of flash and ambient images corresponds to the illumination due to the flash only, which is proportional to the surface albedo at each pixel p.

Our approach is applied per channel to get a suitable threshold for the new illumination. Using the luminance difference we find a mask of the ambient image proportion to the difference image and ignore the low confidence pixels. The final threshold is achieved by taking the mean of the remaining pixels.

White Balancing

Flash and No-flash image

White Balanced image

White Balancing

White balanced images (our result)

White Balanced image (result in paper)

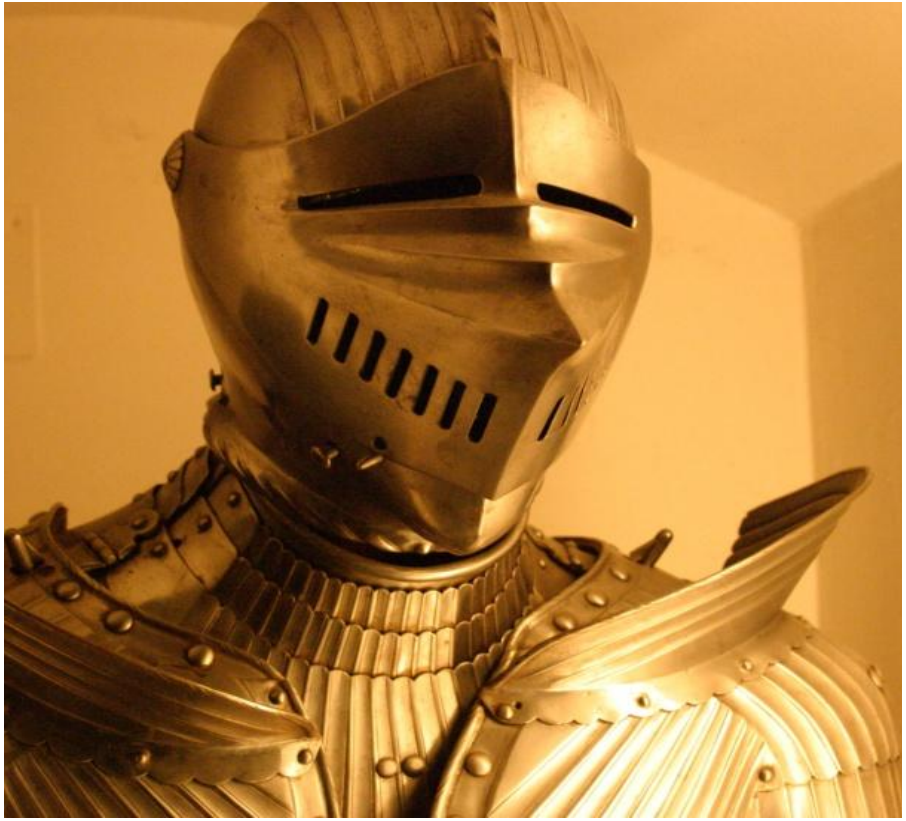
Continuous Flash Adjustment

When taking a flash image, the intensity of the flash can sometimes be too bright, saturating a nearby object, or it can be too dim, leaving mid-distance objects under-exposed. With a flash and non-flash image pair, we can let the user adjust the flash intensity after the picture has been taken simply by interpolation/extrapolation of the flash and ambient images in the YCbCr color space.

Flash Adjustment

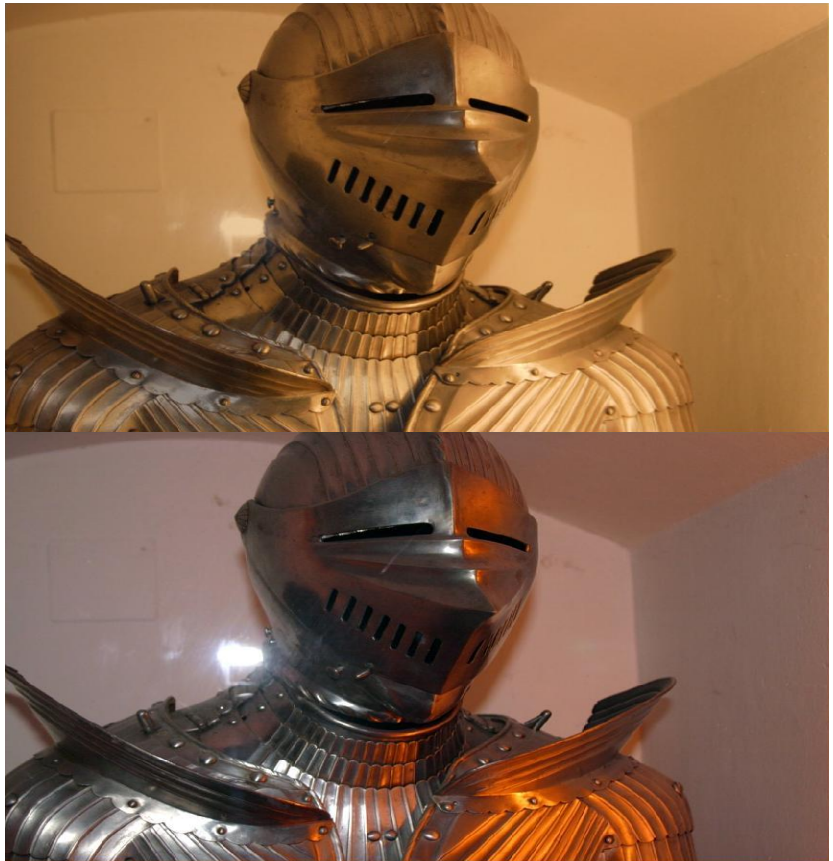
Flash Image

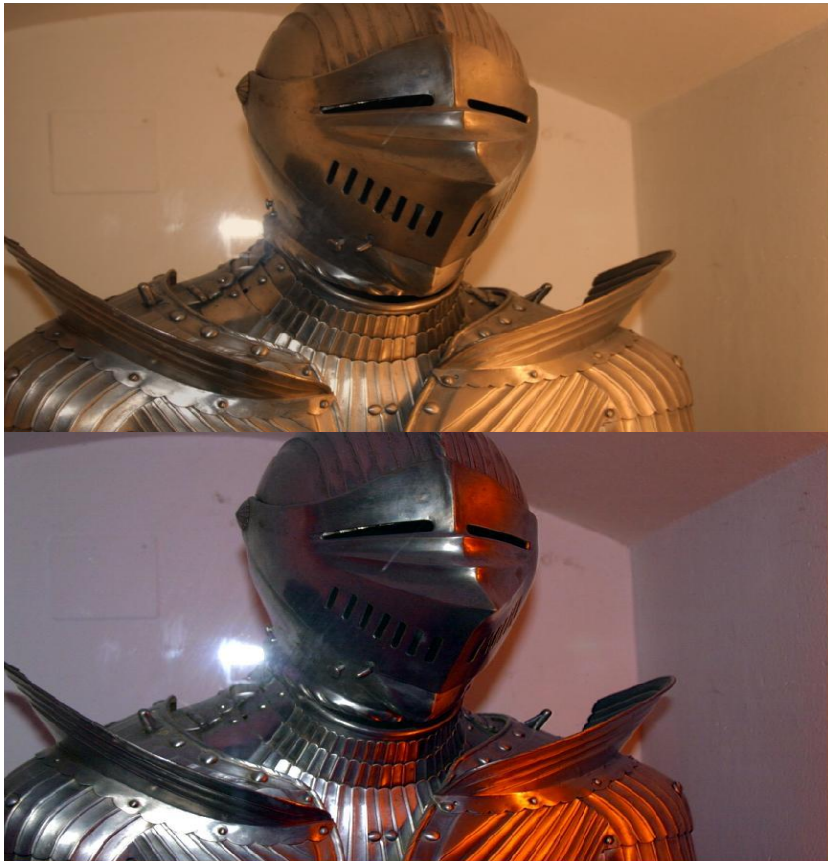
No-Flash image



Flash Adjustment

Flash adjusted with alpha - 0.5, 0.8, 1.2, 1.5





Red-Eye Correction

➔ to repair artifacts in the flash image

Our red-eye removal algorithm considers the change in pupil color between the ambient image (where it is usually very dark) and the flash image (where it may be red). We convert the image pair into YCbCr space to decorrelate luminance from chrominance and compute a relative redness measure.

We then use a threshold to get regions above a particular redness value based on mean and variance. After this we put spatial constraints to detect a pair of eyes based on shape and distance of the regions detected.

Red Eye Removal

Flash Image with red eye

Red eye Corrected

Implementation

- ➔ Denoising and detail transfer -
  - Joint Bilateral and flash shadow removal - Shubham Agarwal
  - Detail Transfer - Swati Dewan
- ➔ White Balancing -
  - Histogram Analysis, Thresholding - Shubham Agarwal
- ➔ Continuous Flash Adjustment -
  - luminance thresholding, interpolation - Shubham Agarwal
- ➔ Red eye Correction -
  - Chrominance based thresholding, eye pair detection - Swati Dewan

Strengths/Weakness

➔ Strengths

- Ambient color tone is retained in the final image
- High frequency details are not lost (rather added in some cases)
- Noise in the non-flash doesn’t affect the results much
- Extra shadows produced by flash are removed

➔ Weakness

- Shadow detection doesn’t work that properly(unless thresholded manually) especially in high-intensity images resulting in false regions being detected as shadows too.

Thank You