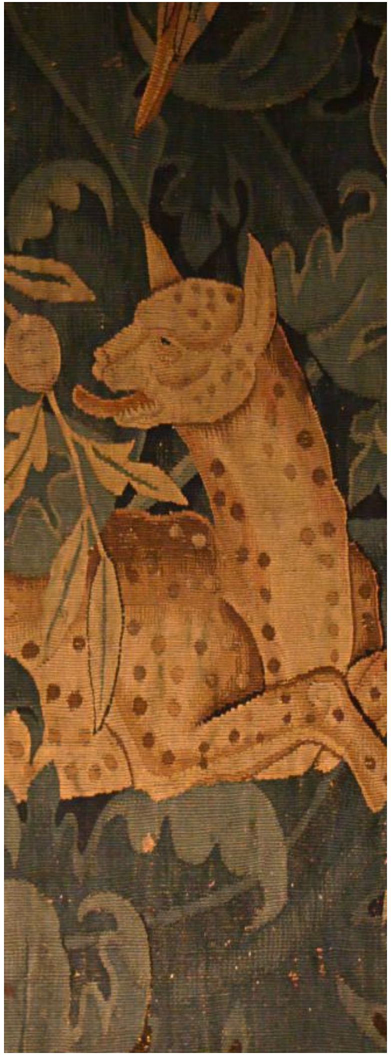

CS663 Project : Digital Photography with Flash and No-flash pairs

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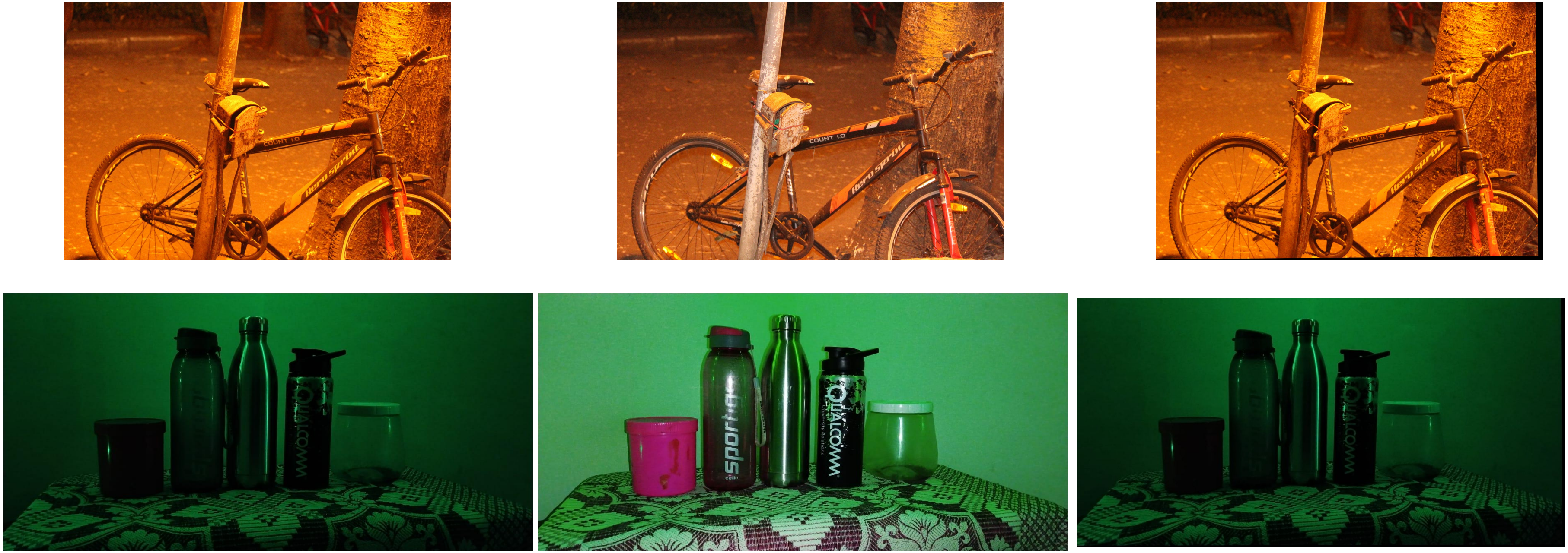
Image Registration

Method :

- Used the Registration estimator app of the image processing toolkit
- Choose Flash image as the fixed image
- Choose the Registration Technique (eg. SURF, Harris)
- Generate the matlab function to extract the transform vector
- Use the Transform vector separately on the 3 channels to get the registered image

Image Registration



moving fixed registered

Image Registration : Difference Images

Fixed - Moving

Fixed - Registered

Joint Bilateral Filtering

Method :

- We did this by two methods :
  - By applying JBF to the three channels separately with different weights
  - By applying JBF to the three channels separately using the same smoothing weights
- In the above we demonstrate only the combined bilateral filter
- Later on the smoothing using the separate bilateral filter and the PCA based denoising is discussed.

Joint Bilateral Filtering

Ambient

Filtered

Flash Shadow and specularity detection

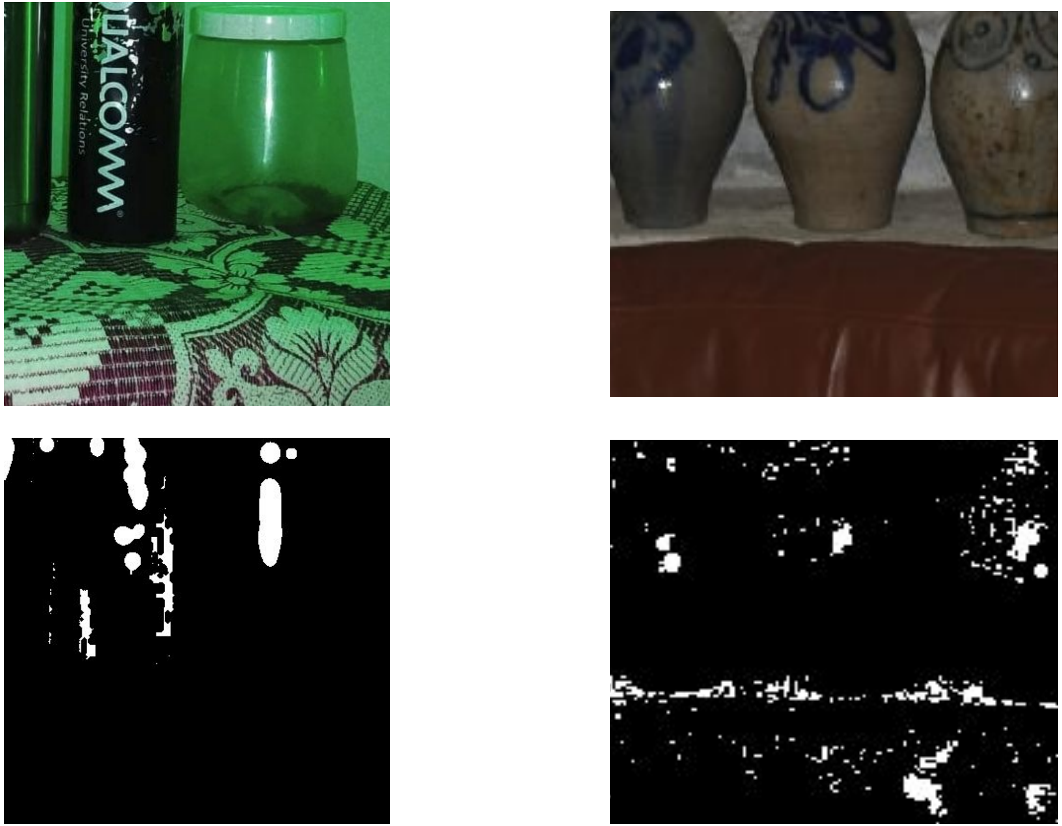
Method :

- The shadows were detected using the fact that illumination difference between the flash image and the no flash image should be higher at every pixel but due to shadows some of the pixels will be lower than the ambient level. We detect such pixels and include them in our shadow mask. The following formula was used to calculate the luminance

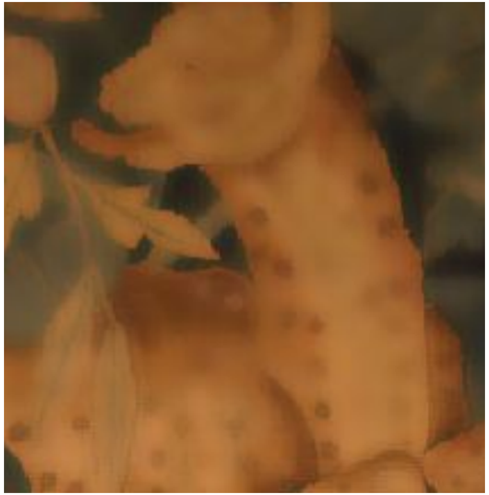
$$Y'_{709} = 0.2126R' + 0.7152G' + 0.0722B'$$

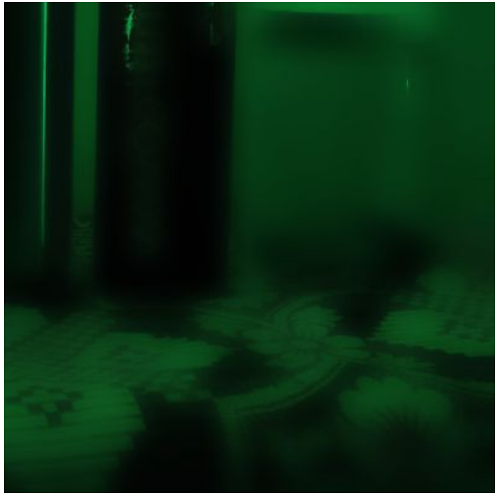
- For detecting the specularities we detect the pixels with the values greater than the 95% of the maximum value
- The mask is eroded due to the correct for the noise values
- Some observation regarding this are discussed later

Flash Shadow and specularity detection



Ambient Image Denoising





The ambient image was filtered using the bilateral filter to obtain the above images

Detail Transfer

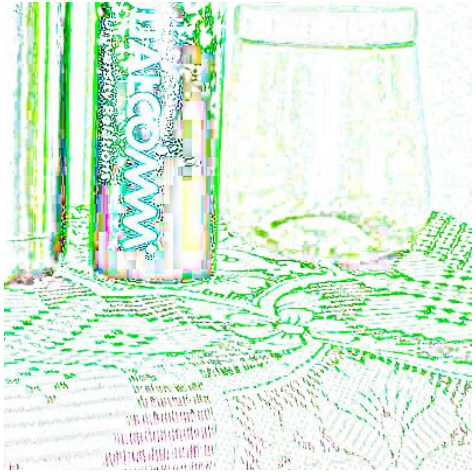
Method :

- The method as discussed in the paper was implemented for this part
- The ratio image of Flash and the smoothed version of the Flash image was used to obtain the Image containing the information about the details

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

- Here epsilon is used to avoid the division by zero and generation of spurious details.
- As mentioned in the paper we used the value of epsilon as 0.02 at first but noticed that even very small values of epsilon worked pretty well

Detail Transfer



Final Output : Carpet Image

Ambient

Detail transferred and Filtered

Final Output : Bottle Image

Ambient

Detail transferred and Filtered

Final Output : Bottle Image

No flash

Flash

Detail transferred

Final Output : Cave Image

Ambient

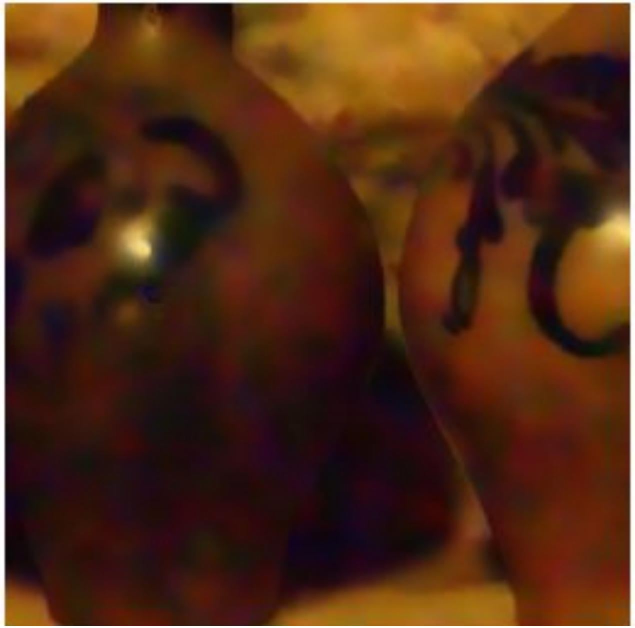
Detail transferred and Filtered

Carpet image output with mask in detail transfer

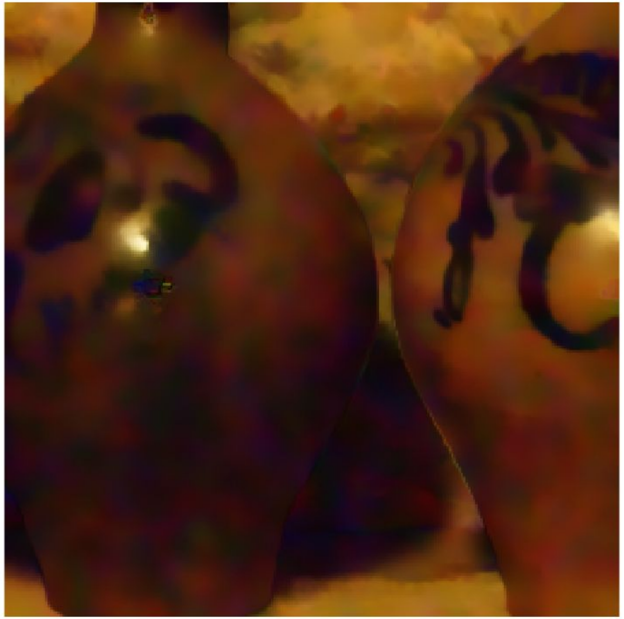
Carpet image output with mask in detail transfer

The difference in the above two images is due to the mask not being able to differentiate between the shadows perfectly and labelling some regions of the carpet as shadow.

Denoising using the separate and Combined smoothing weights



Separate Weights



Combined Weights

Denoising using the separate and Combined smoothing weights

Separate Weights

Combined Weights

PCA Based Denoising

Original Image

Combined PCA

Separate PCA

Epsilon in Detail Calculation

- Value of epsilon was varied from eps to large value
- Very small values didn't have any change on variation
- With large values details were not being added because epsilon overpowers the values of F and F_base
- Also tried a variation with epsilon constant in the numerator and varying only in the denominator
    - In this case the image's intensity levels were varying inversely proportional to epsilon

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

Epsilon in Detail Calculation

Epsilon = eps

Epsilon = 0.02

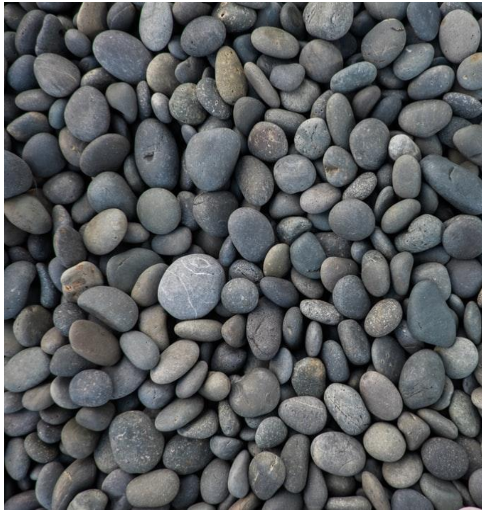
Epsilon = 0.1

Varying F_{base} smoothing level

Result with acceptable F_{base} smoothing

Result with high F_{base} smoothing - Halo effects

Texture transfer using joint bilateral filter



White balancing

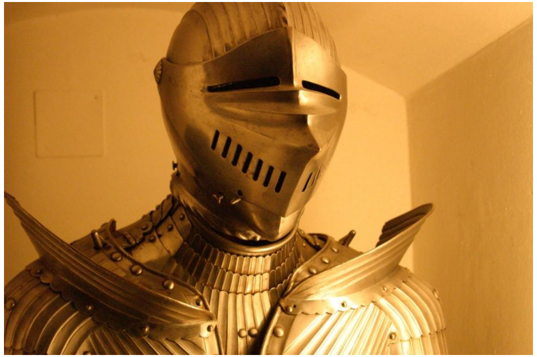
Continuous Flash (dataset image)

Alpha = 0

Alpha = 0.25

Alpha = 0.5

Alpha = 0.75



Alpha = 1

Continuous Flash (dataset image)

Alpha = 0

Alpha = 0.25

Alpha = 0.5

Alpha = 0.75

Alpha = 1

Continuous Flash (acquired image)

Alpha = 0

Alpha = 0.25

Alpha = 0.5

Alpha = 0.75

Alpha = 1

Continuous Flash (acquired image)

Alpha = 1

Alpha = 0.75

Alpha = 0.5

Alpha = 0.25

Alpha = 0

Conclusions

- We have demonstrated a set of applications that combine the strengths of flash and no-flash photographs to synthesize new images that are of better quality than either of the originals.
- Also the application of flash and no flash photograph to white balancing and continuous flash image creation was studied.
- For the denoising part Joint Bilateral Filtering with same smoothing weights was found to work better than JBF with different weights (the one used in paper) and also the PCA based denoising algorithm.
- The image registration algorithm used here accounts only for in plane rotation.
- Another interesting application of JBF, texture transfer was also implemented just as an exercise to test the JBF code.

Link to results folder :

https://drive.google.com/drive/folders/1SZ5xTnMtQvSfW4F0bm56ARqQW1CAhcvb?usp=sharing