DIP PROJECT PROPOSAL

Digital Photography with flash and no flash image pairs

Project ID: 8

Link to the project repo : Link

Team : DIPped in chutney

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Main Goals

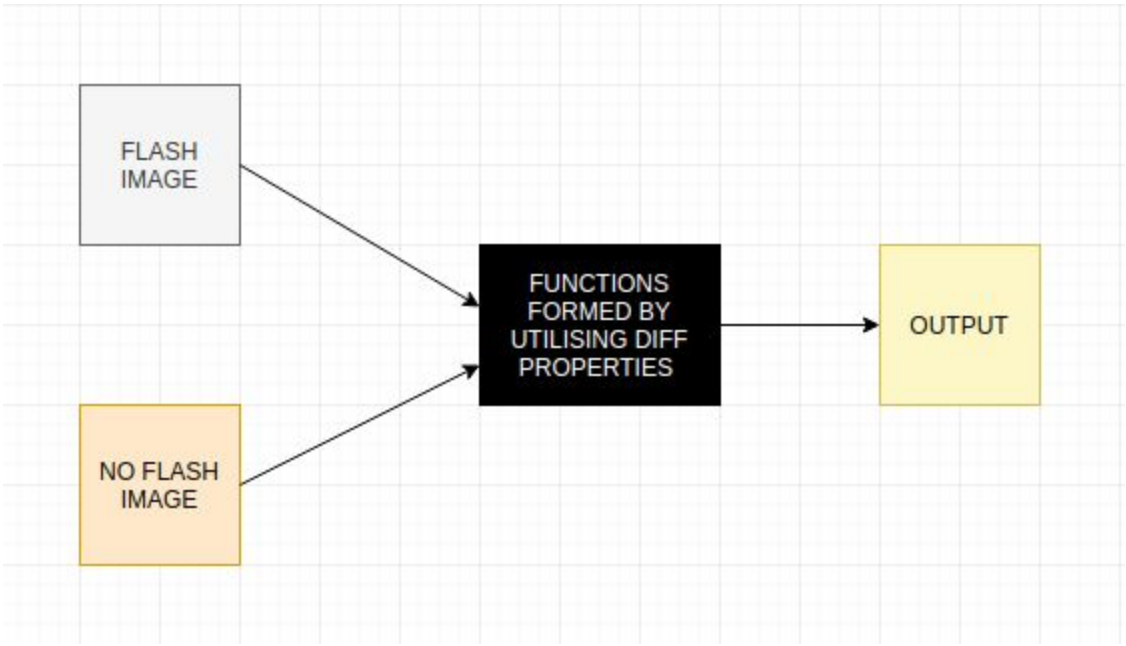
We perform a variety of applications that analyze and combine the strengths of flash/no-flash image pairs.

Our applications include

- **Denoising, detail transfer and shadow masks** (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)
- **Red-eye removal** (to repair artifacts in the flash image).

Problem Definition

Flash photography was invented to remove the problem faced by the photographers while clicking pictures in low light conditions. By adding artificial light to nearby objects in the scene, cameras with flash can use shorter exposure times, smaller apertures, and less sensor gain and still capture enough light to produce relatively sharp, noise-free images, however the use of flash can also have a negative impact on the lighting characteristics of the environment. Objects near the camera are disproportionately brightened. In addition, the flash may introduce unwanted artifacts such as red eye, harsh shadows, and specularities, none of which are part of the natural scene.



Approach Taken

We use the details from the flash and no flash images, and perform the following functions to improve our pictures

- **Ambient image denoising** :
    - The bilateral filter either under blurs or over blurs the image. The flash image contains more information about the true high frequency detail as compared to the ambient image. So we will use that to modify the normal bilateral into a joint bilateral filter.

    - We will then further detect flash shadows from the flash image and use that mask to improve upon the result from the joint bilateral filter.

    - We transfer high-frequency detail from the flash image to the denoised ambient image, since this detail may not exist in the original ambient image. We get the detailed layer by dividing the original flash image with the basic bilateral filtered image. We add the laplacian filtered flash image to the enhance the detail layer.

- **White balancing** :
    - The difference between the luminance of the flash image and the ambient image is the illumination due to the flash only, which is proportional to the surface albedo at each pixel. Our approach is applied per channel to get the suitable threshold for the new illumination.
    - Using the luminance difference we find a mask of the ambient image proportion to the difference image.
    - We ignore the low confidence pixels.
    - The final threshold is calculated by taking the mean of the resultant pixels.

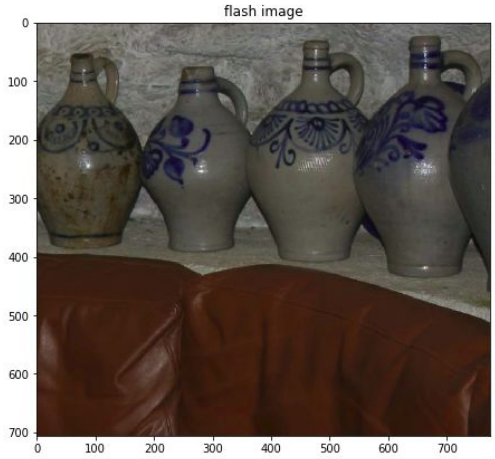
- **Continuous flash intensity adjustment** :
    - This can be done by extrapolation/interpolation of flash and ambient images in the YCbCr color space.

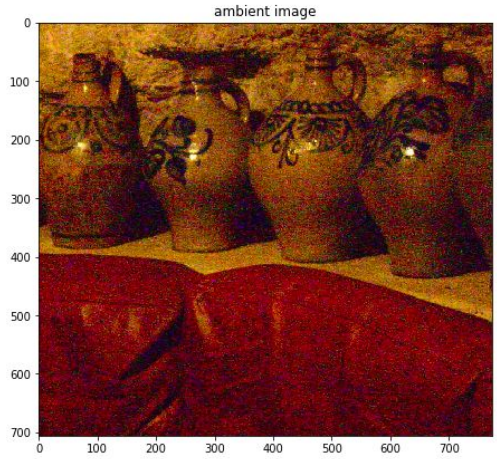
- **Red-eye correction** :
    - We perform red-eye detection by considering how the color of the pupil changes between the ambient and flash images.
    - We then calculate redness by converting the image pair into YCbCr space to decorrelate luminance form chrominance.
    - We use a threshold to get the regions above a particular redness value.
    - After that we use certain spatial constraints to detect the pair of eyes.

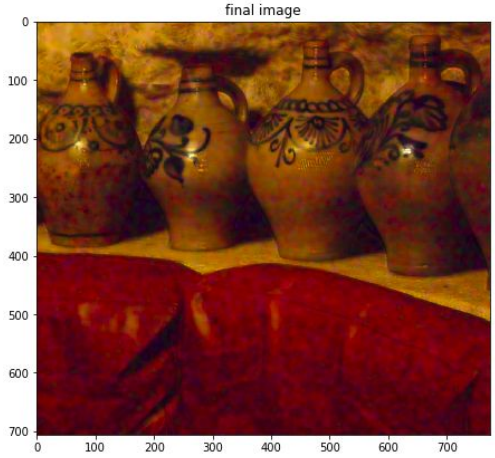
Experiments Performed/RESULTS/INFERENCES

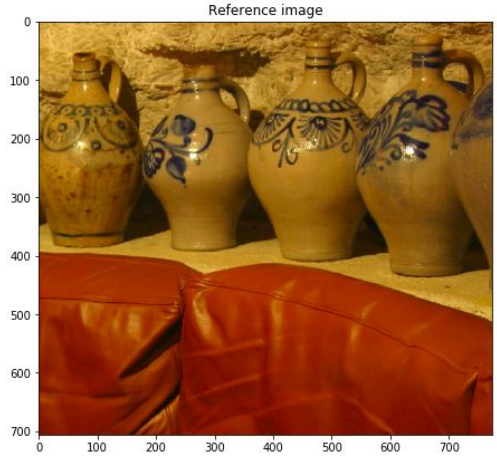
- **Ambient Image Denoising :** Implemented the steps to perform ambient image denoising in python3.6.

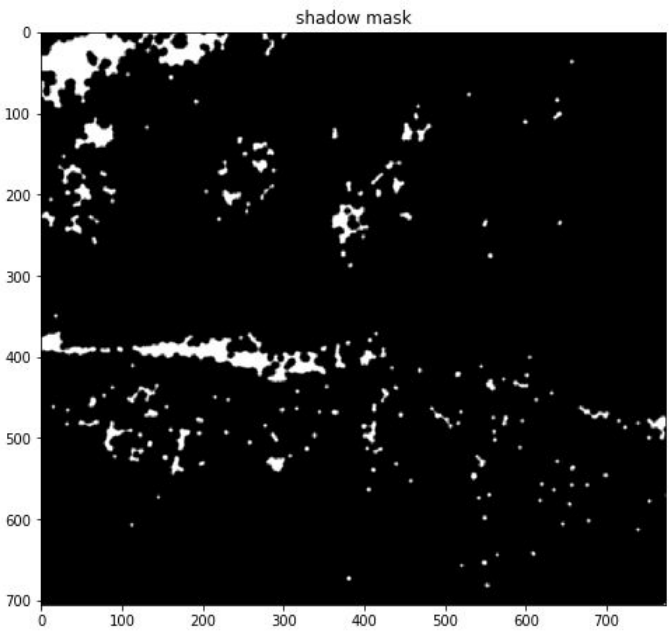
  Tested with the images given as a part of the paper. The first example shown below is of the cave image from the dataset. The first row contains input flash/no_flash pair. The next row contains the final image after denoising and the reference image for comparison. Below that is the shadow mask obtained for shadow removal.


flash image


ambient image

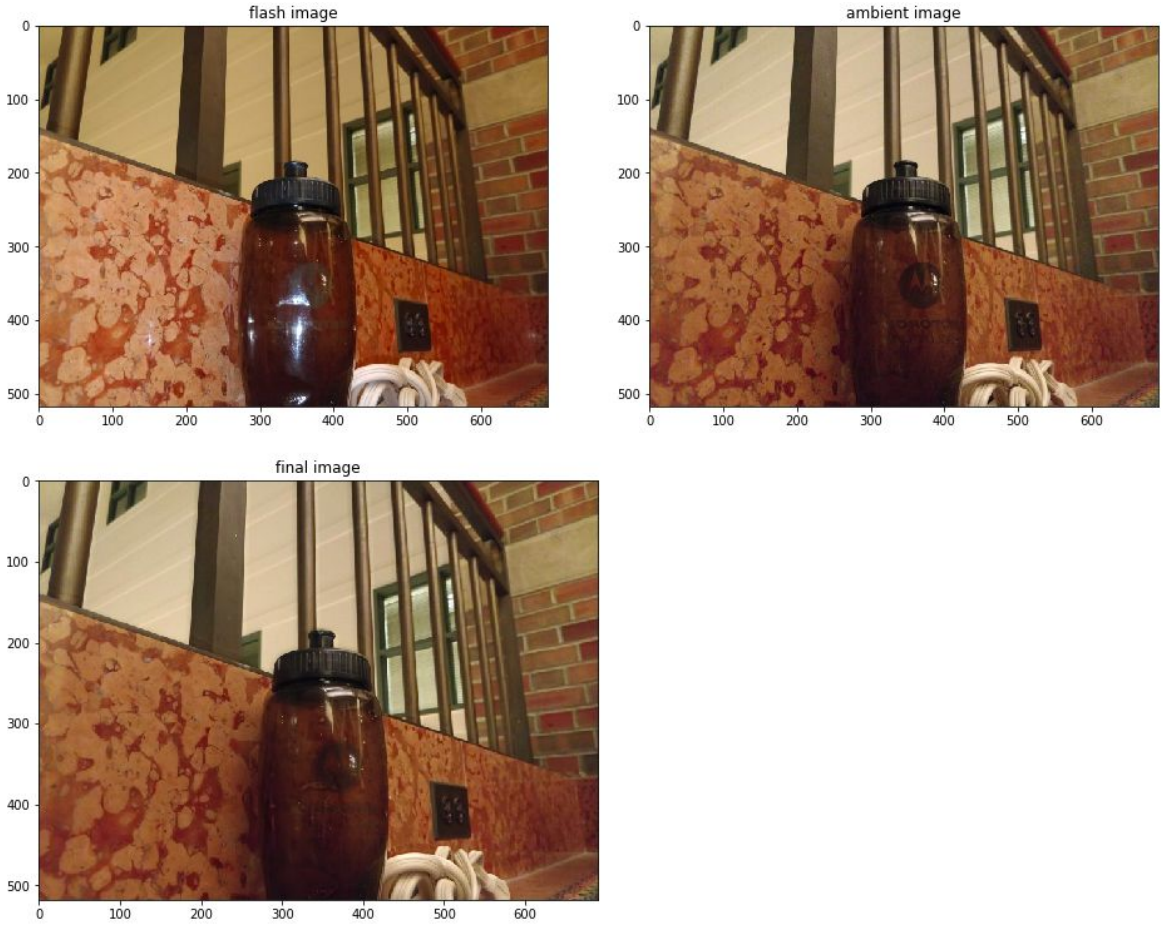

final image


Reference image


shadow mask

The first picture above in the second row is the output image produced by my implementation of denoising. When you compare it with the ambient image it is more smoothed and on closer observation we see small details which are absent in the ambient image present in the final due to the details added due to the flash illumination in image 1.

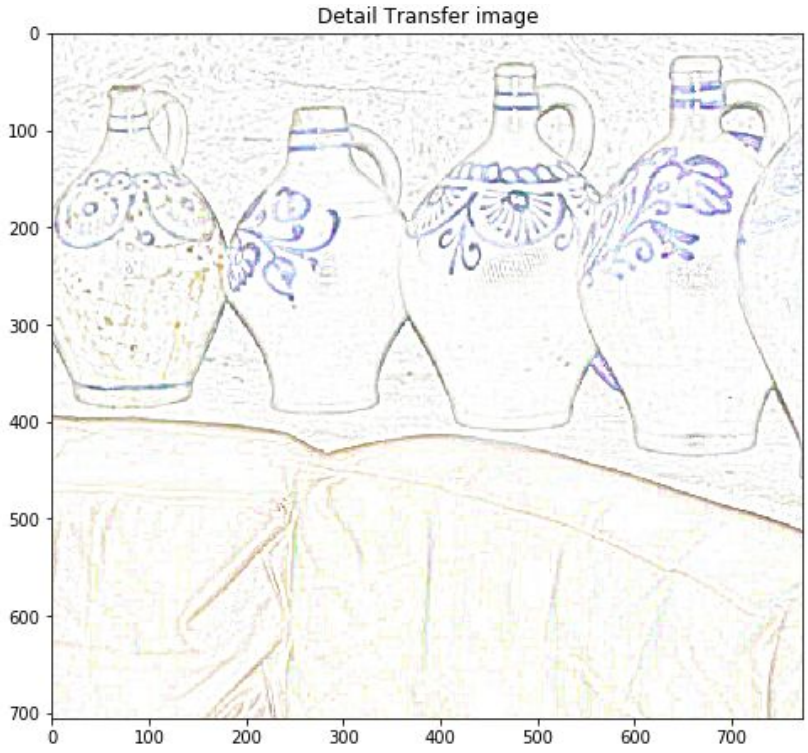
The single image (above) is the flash shadow mask of the image. I,e the shadows that appear due to flash these are removed from the images to make them look better.



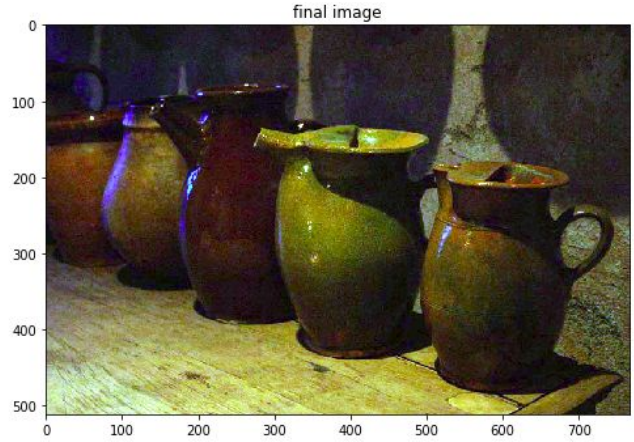
This image is taken using a normal phone flash and lens. So the flash here does not contain much detail and since the obtained image is very similar to the input images.

Detail Transfer

Below are the detail transfer images obtained by the detail transfer step. This image is added to the final output image to produce a very fine and sharp output. These details are captured in the flash image due to very high intensity values.

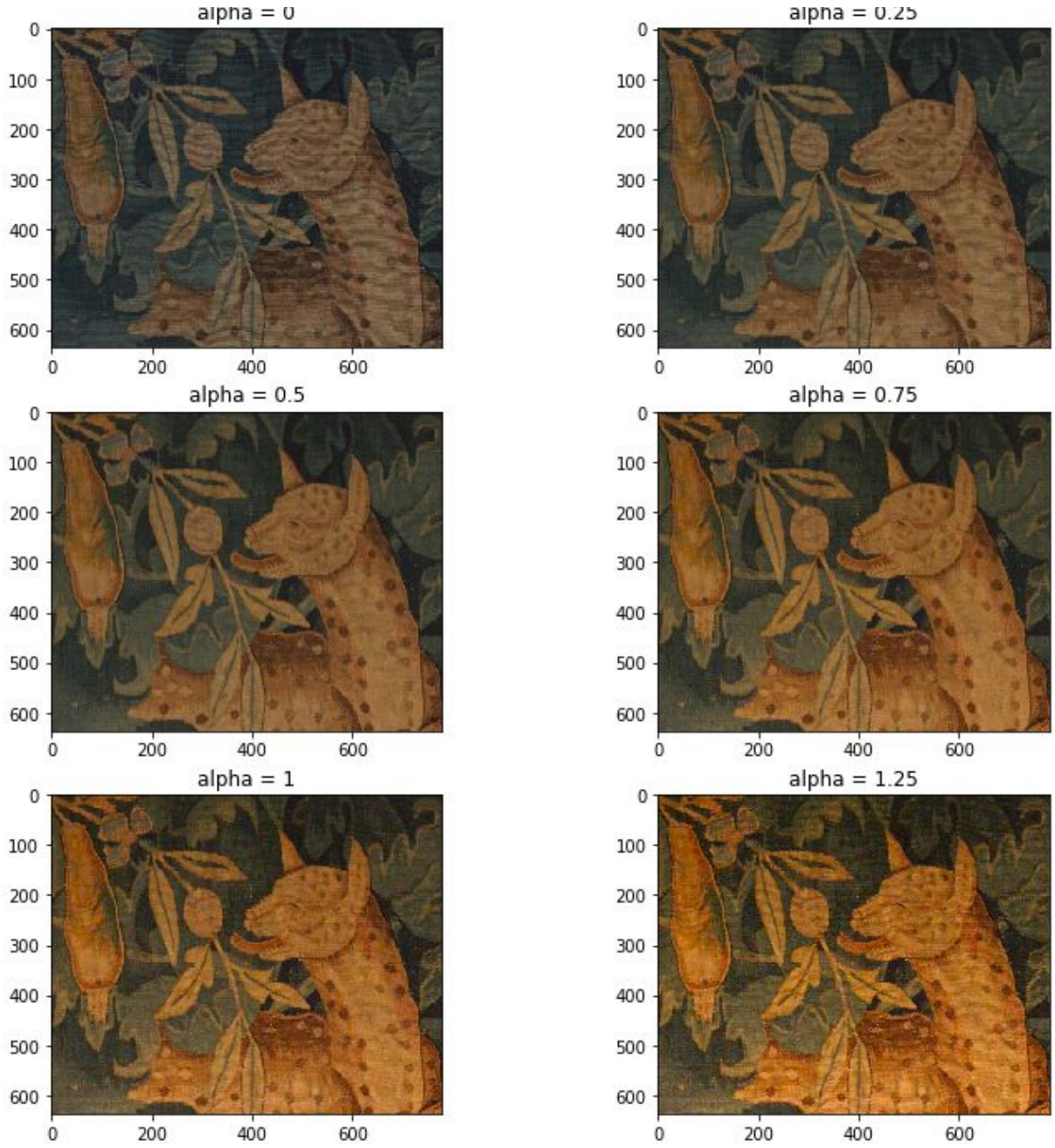


White Balancing

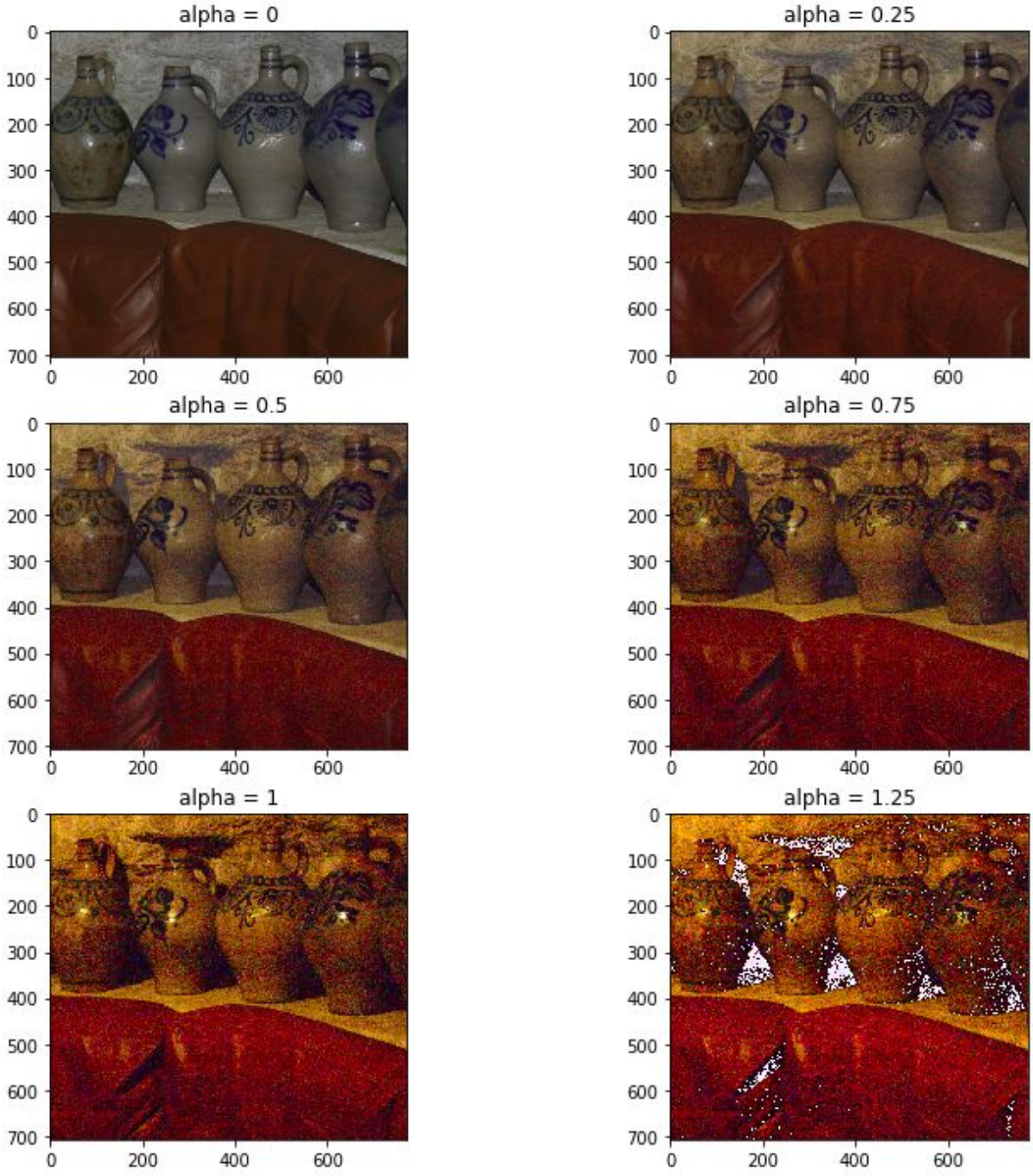


The first two are the flash and no flash input images. The final one is the image produced due to white balancing.

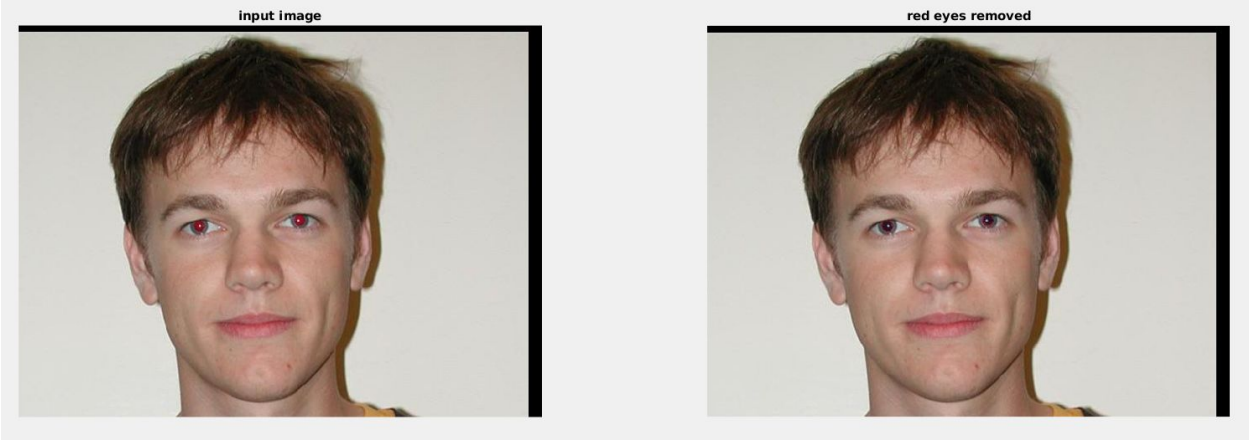
Flash Adjustment

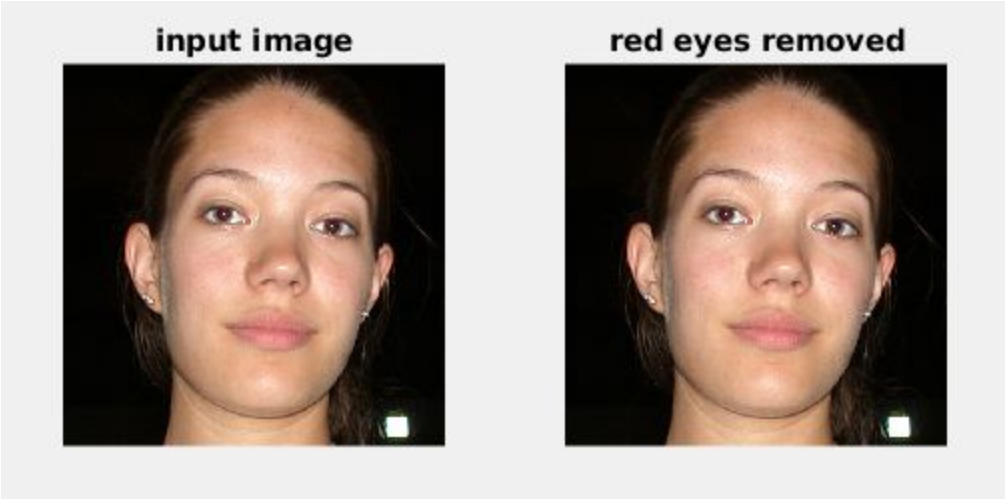


In this example the images were successfully transformed from no flash to a stage where flash is even more than that of the input image. Here notice alpha is greater than 1. But in some case this results in errors due to overflow. See below example.


alpha = 0
alpha = 0.25
alpha = 0.5
alpha = 0.75
alpha = 1
alpha = 1.25
0
100
200
300
400
500
600
700
0
200
400
600

Red Eye Removal





These are the outputs obtained on the dataset given to us by the authors. Here the red eyes occurrence due to the flash image has been removed and the non red eye image from the no flash image.

The second image shows a close up with a faint red eye

Task Assignment table

Task	Pranay's Contribution	Swapnil's Contribution
Denoising and Detail Transfer	1	0
Shadow Removal	0.5	0.5
White Balancing	0	1
Flash Adjustment	0	1
Red Eye Removal	1	0