Computer Vision LAB 3 Report

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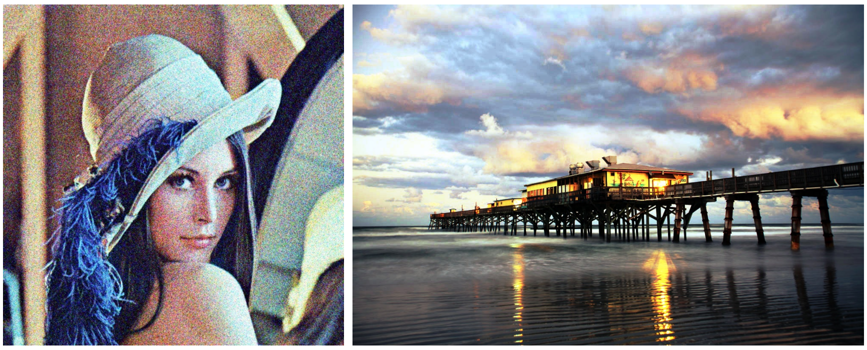
1 Goal

The objective of this homework is show the difference in histogram equalization applied in different color space and the implementation of three filters seen during class through a system of classes and their effect varying the parameters.

2 Procedure

We perform the histogram equalization in two different ways for the two color spaces considered, BGR and HSV, since the channels have different meaning for each color space. For the first one, the histogram equalization is computed on each channel separately while for the second one the histograms equalization is computed on one channel at time while the other two are maintained without changes. At first sight is clearly visible the RGB equalization changes the color of pixels greatly as in the figure (1b). This makes the images with warm tint more cold, since it push the histogram of blue channel that is condensed in the low values more high, making the opposite in the red channel histogram. A similar phenomena is observable in an image with cold tint, that will be made warmer. Regarding the HSV color space, if the Hue channel is equalized we can observe that the images are still a little understandable but the color are all wrong since we are flattering the histogram of the colors channel. In the Saturation channel, in the first image we can observe that there is a improvement but in the other one, as in the hue case, the color are changed too much so it is not a good general choice. Considering the Value channel, that can be seen as the brightness, we can observe a better enhancing in the figures (1e). The tints are the same as the originals but the overexposed image is darkened without much alteration of the colors. This histogram equalization doesn't flatten the RGB histograms but aims to improve the look of the image. In fact, in the first case changing the 3 components modifies the resulting color of the pixel while in this way we maintain the color unchanged but the darkness and brigthness are balanced.
At this point the V equalized image, the best one till now, is filtered through three filters: Median, Gaussian and Bilateral filter. To implement these filters are created four class, one for each filter and a generic `Filter` class from which the other are derived. This implementation makes managing the various filters simple. The effects of the Median filter is noticeable in noisy images, since it removes pixels with high sudden changes. We can observe that figure (2a) shows how the noise is less noticeable loosing a bit of quality. Increasing the size the image become more blured, removing small details, till the elements become blobs of quasi constant color and difficult to distinguish.
The Gaussian filter effect is more obvious: increasing the value of sigma and the window size the output image results more blured and the fine details are unrecognizable. This helps to remove some noise and smooth squared colored areas obtained from the equalization. If σ is fixed and the size is low the effect is similar to a mean filter, since the values of kernel are quasi constant, while if the window exceed the 6σ rule there are unnoticeable changes, since the kernel in the exceeding area is almost 0.
For the Bilateral filter the size of filter is computed as $6\sigma_s$. This is computationally heavy for large σ_s and for real time filtering will be better to set it to a fixed value, but for understanding better the filter effects is more interesting this setup. The effect of this filter is lighter than the others, in particular it can remove the noise maintaining the structure of most elements, even the small ones. If we use a small σ_c, it is not so useful since the colors are still off in some pixels. Choosing a good tradeoff, as in figure (4b), is observable a less grainy image, with a subject well defined. For high σ_c the image assume a cartoonish look as can be seen in figure (4c). If σ_c is too high the bilateral filter behaves like a slow gaussian filter due to the more complex code, as can be seen comparing figures (3b) and (4d).

(a) Original Images



(b) BGR Equalized

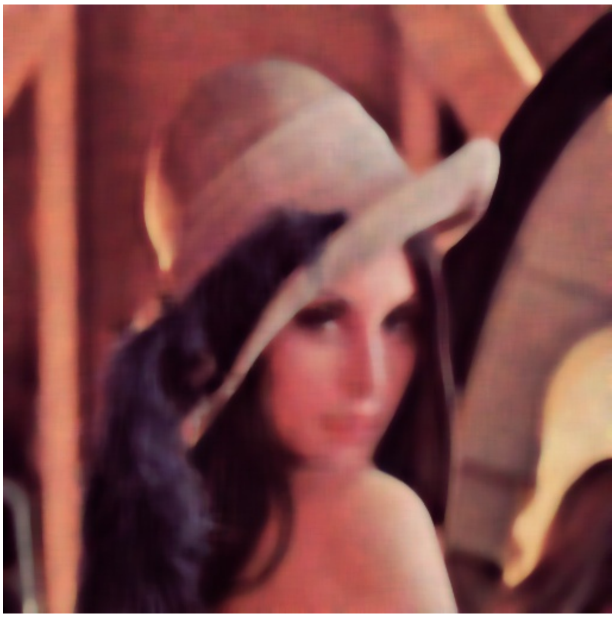
(c) H Equalized

(d) S Equalized

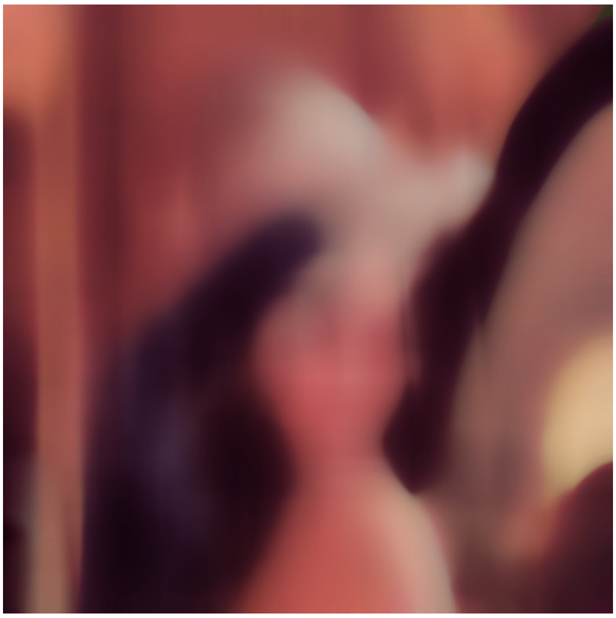
(e) V Equalized

Figure 1: Example of histograms equalization on different images

(a) Size=5, denoise effcet



(b) Size=15, high value



(c) Size=50, blob effect

Figure 2: Example of Median filter with various size

(a) Size=11, low value

(b) Size=31≈6σ, tipical choice

(c) Size=61, large value

Figure 3: Example of Gaussian filter with $\sigma = 5$ and changing size

(a) σ_c=10, σ_s=50

(b) σ_c=150, σ_s=3

(c) σ_c=200, σ_s=5

(d) σ_c=500, σ_s=5

Figure 4: Example with Bilater filter with various parameters