Università degli Studi di Padova

ICT for Internet and Multimedia

COMPUTER VISION

LAB-2 HOMEWORK REPORT

HISTOGRAM EQUALIZATION AND IMAGE FILTERING

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1 Introduction

Histogram equalization and image filtering are very common methods used in image processing.

Histogram equalization is a method used to correct color distribution distortion caused by the clustering of color values in an image. This method doesn't improve every image. It is effective only in images where all pixels have a color value within a certain range.

Image filtering is a technique through which size, colors, shading and other characteristics of an image are altered. An image filter is used to transform the image using different graphical editing techniques.

We are going to use RGB and Lab histogram equalization and non-linear image filtering methods in this study.

2 Main Tasks

In this study, we are required to do an histogram equalization in 2 different color space and after that, removing the noise using 3 different non-linear image filtering methods.

2.1 Histogram Equalization

Histogram equalization is a computer image processing technique used to improve contrast in images. It accomplishes this by effectively spreading out the most frequent intensity values, i.e. stretching out the intensity range of the image. This method usually increases the global contrast of images when its usable data is represented by close contrast values. This allows for areas of lower local contrast to gain a higher contrast.

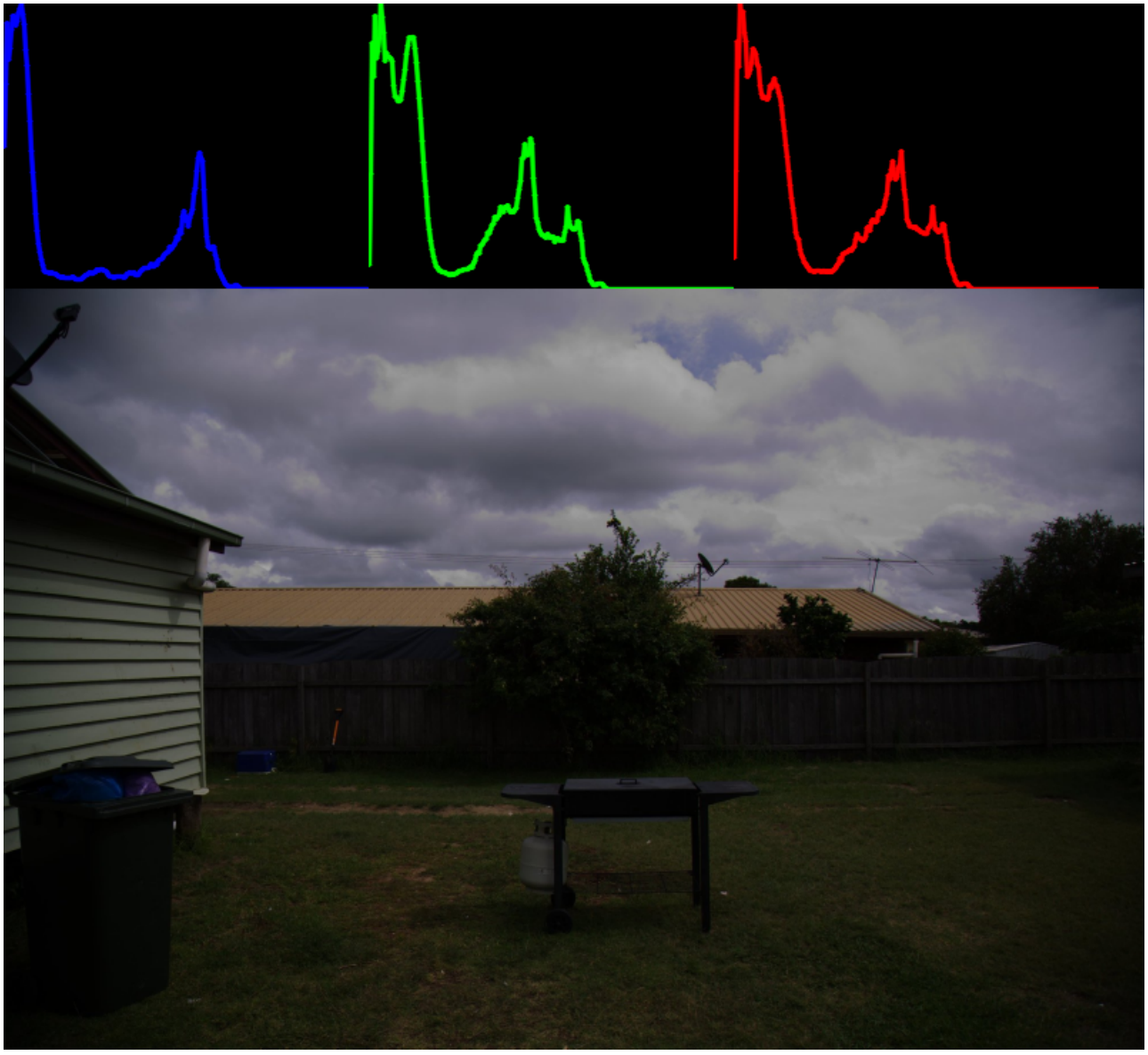

Figure 1: Original Image and Histogram

In Figure 1, we can see the original input and its histogram graphichs in RGB color space. As you can see from the graphics, there is an unbalanced distribution between colors.

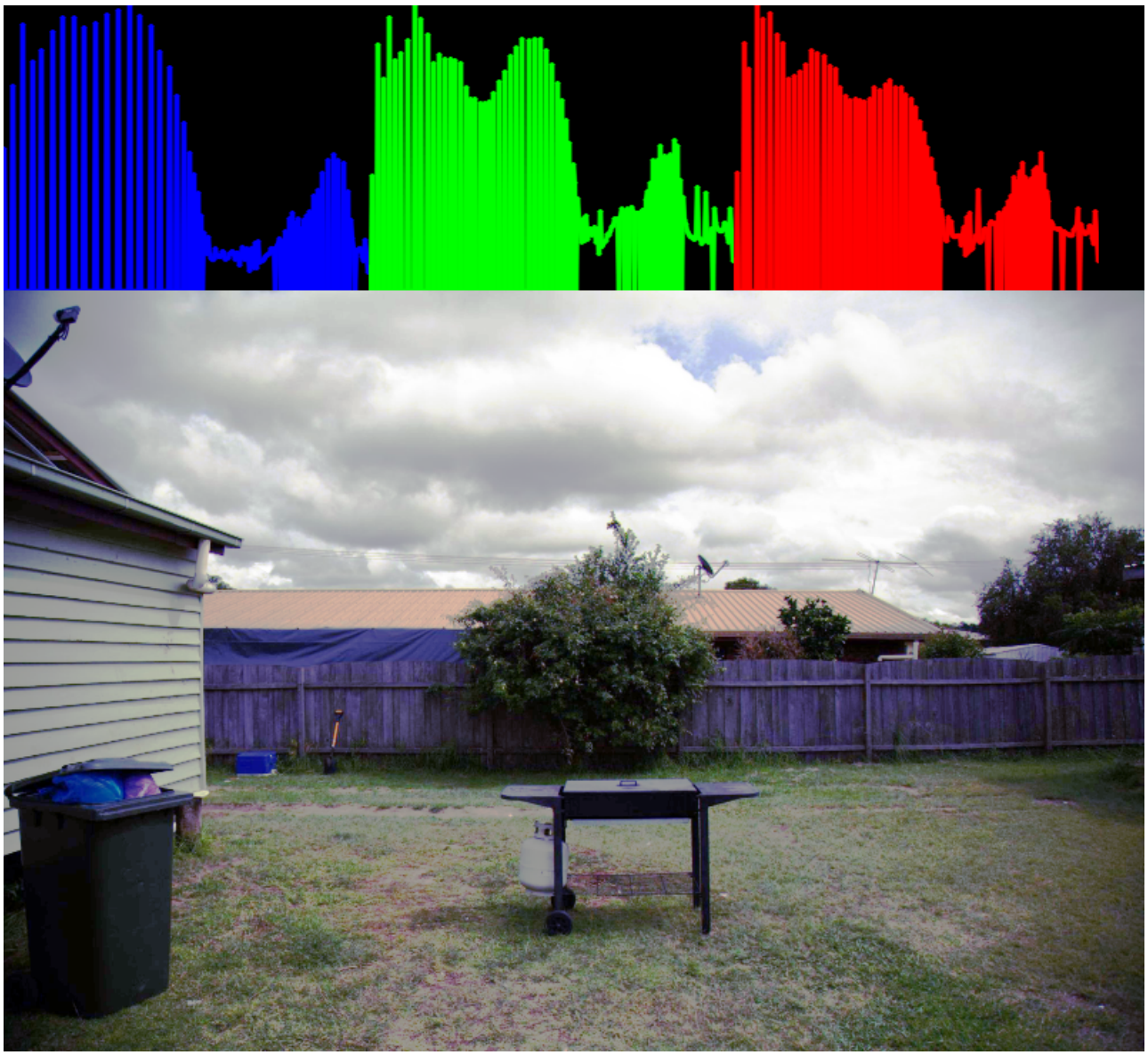

Figure 2: Equalized (RGB) Image and Histogram

In Figure 2, we can see the equalized image and its histogram graphics. In this picture, we see the darker parts in original image gets lighter and there is more evenly distribution between colors. But some of the colors are brighter that they should be in real. This is because of RGB color space and we can counter this problem by using Lab color space.

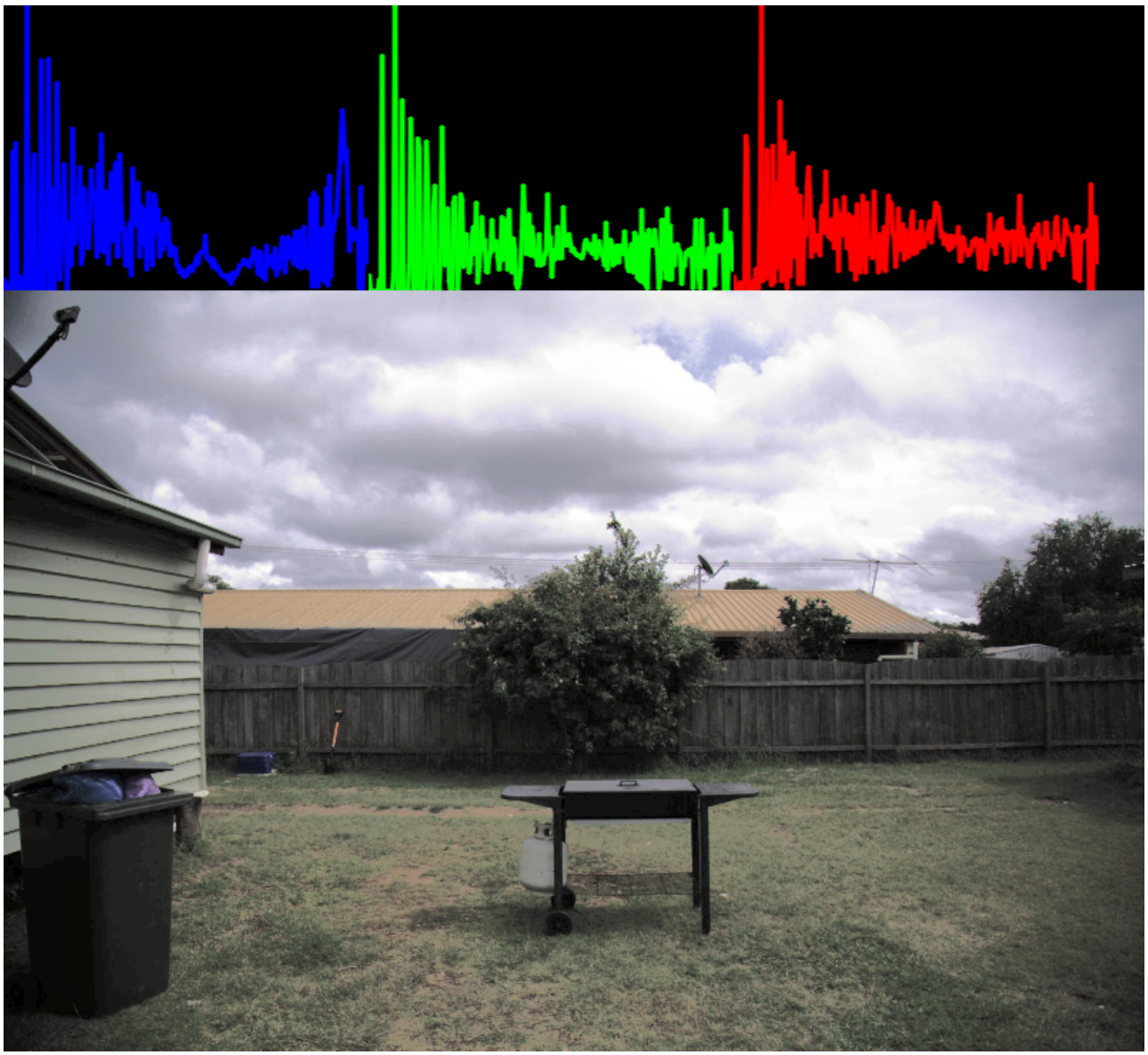

Figure 3: Equalized (Lab) Image and Histogram

In Figure 3, we can see a better equalized image. The reason for that is we used Lab color space and equalized only the 'L' channel. This gives us better lightning in the picture and more equalized histogram.

2.2 Image Filtering

In this section, we used 3 different image filtering method; Median Blur, Gaussian Blur and Bilateral Filtering.

2.2.1 Median Blur

The Median blur operation is similar to the other averaging methods. Here, the central element of the image is replaced by the median of all the pixels in the kernel area. This operation processes the edges while removing the noise. Median filtering is very widely used in digital image processing because, under certain conditions, it preserves edges while removing noise, also having applications in signal processing.

(a) Median Blur with k=1

(b) Median Blur with k=4

(c) Median Blur with k=7

(d) Median Blur with k=11

Figure 4: Median Blur Filtering

As we can see from the outputs, although it depends on the photo, the smaller kernel values are more effective than larger kernel values. The higher kernel value means more blurred picture.

2.2.2 Gaussian Blur

In a Gaussian blur, the pixels nearest the centre of the kernel are given more weight than those far away from the centre. The rate at which this weight diminishes is determined by a Gaussian function, hence the name Gaussian blur. It is a widely used effect in graphics software, typically to reduce image noise and reduce detail. The visual effect of this blurring technique is a smooth blur resembling that of viewing the image through a translucent screen, distinctly different from the bokeh effect produced by an out-of-focus lens or the shadow of an object under usual illumination.

(a) Gaussian Blur with k=4 and s=2

(b) Gaussian Blur with k=28 and s=2

(c) Gaussian Blur with k=10 and s=10

(d) Gaussian Blur with k=4 and s=16

Figure 5: Gaussian Blur Filtering

We can see from the pictures that the kernel value itself has almost no effect on filter but with the sigma value, we start to see the Gaussian Blurring. While sigma value is increasing, the details like grass start to distinguish from the picture and the picture starts to become softer.

2.2.3 Bilateral Filter

The bilateral filter smooths an input image while preserving its edges. Each pixel is replaced by a weighted average of its neighbors. Each neighbor is weighted by a spatial component that penalizes distant pixels and range component that penalizes pixels with a different intensity. This weight can be based on a Gaussian distribution. Crucially, the weights depend not only on Euclidean distance of pixels, but also on the radiometric differences (e.g., range differences, such as color intensity, depth distance, etc.).

(a) Bilateral Filter with k=1, r=1, and s=1

(b) Bilateral Filter with k=6, r=61, and s=3

(c) Bilateral Filter with k=5, r=28, and s=17

(d) Bilateral Filter with k=6, r=40, and s=40

(e) Bilateral Filter with k=6, r=80, and s=40

(f) Bilateral Filter with k=6, r=38, and s=95

Figure 6: Bilateral Filtering

The pictures tell us that with sigma-r and sigma-s values are increasing, the clearer pictures we get. In this filtering, the suggested kernel value is 5. Below the level of 10, they have almost no effect but after the 20, they start to clean the pictures. Above 100, they show their highest effets. The higher sigma-r value, the more blurred pictures. The higher sigma-s value, the clearer pictures.

3 Conclusion

In this study, we learned what is histogram and how can we use it in our images, the different histogram methods (RGB and Lab color spaces) and how they effect to images. Also we see the implementations of 3 different filtering methods with different parameters, how these parameters effect the filtering.

Median blurring is effective in removing the pepper-salt noise with small kernel values. It is a typical preprocessing step used to improve the results of further processing.

Gaussian blurring is used to remove the noise, softer the picture and reduce the pixels.

Bilateral filter is very effective in preserving the edges while removing the noise. The real improvement in this filter is in higher sigma-s values.