Application of Gaussian and Laplacian pyramids

Laura Munar
Universidad de los Andes
l.munar10@uniandes.edu.co

Maria Ana Ortiz
Universidad de los Andes
ma.ortiz1@uniandes.edu.co

1. Introduction

An image pyramid is a collection of images that are successively downsampled. There are two common kinds of image pyramids: Gaussian pyramid and Laplacian pyramid. The first one is used to downsample images and the Laplacian pyramid is used to reconstruct and unsampled image from an image lower in the pyramid. The latter is used in image processing and pattern recognition tasks because of its ease of computation [4].

Hybrid images are a technique that produces static images with two interpretations, which change as a function of viewing distance (double image). These images are based on the multiscale processing of images by the human visual system and can be used to create compelling displays [3].

Hybrid images are generated by superimposing two images at two different spatial scales: the low-spatial scale is obtained by filtering one image with a low pass filter and the high spatial scale is obtained by filtering the second image with a high pass filter; defined as the subtraction of the original image and the image with a low pass filter [3]. The most effective contemporary 'double image' painting may be Salvador Dali's 1940 *Slave Market with the Disappearing Bust of Voltaire*. In this painting, what looks like Voltaire's head from afar is actually a group of characters and an arch opening in the wall, when viewed from a middle distance [2].

Another application of pyramids is Image Blending that is the stack of two images without discontinuities between the images; as it can be seen with direct connection.

The aim of this work is to apply the concepts of image pyramids using natural images to create hybrid and blended images.

2. Materials and Methods

In the following section methods used for developing resulting images of hybrid and blending will be explain.

2.1. Hybrid Images

Hybrid images as mention before are generated by superimposing two images. The process to create it was applying a high pass filter and low pass filter to images shown on Figures 1-2. For the high pass filter a gaussian filter was applied and then subtracting it to original image, remaining the features corresponding to a high pass filter. And for the low pass filter was obtained by applying a gaussian blur. Finally to be able to obtain the hybrid image the corresponding high and low pass filter where added. It is important to emphasize that window size was constant ($35x35$) and that σ value for high and low pass filter were 115 and 50 (for function gaussian_blur from opencv python module[1]). For the previously method the flow diagram is in Figure 3.

Figure 1. Original Image: For Hybrid Images high pass filter was applied

Figure 2. Original Image: For Hybrid Images low pass filter was applied

2.2. Blending Images

The method used for blending was develop by applying Laplacian Pyramids. First by down sampling each image and calculating each Laplacian level and then by merging

two halves in the lower level of each image (Figure 21), and then up sampling the merge image by adding each Laplacian halve level to get back details lost during the down sampling. The gaussian filter used for obtaining the Laplacian pyramids had a window size of $15x15$ and a σ of 20. Expecificly for this method the Pyramids where created by specifying gaussian filter and subsampling or upsampling during the second part of the method.

3. Results

3.1. Hybrid Image

For the application of the method of applying hybrid images the results obtained are shown in Figure 4,5 and 6. In the resulting images, we can observe as the image is subsample one cat is observed and the other starts to show in higher scales.

3.2. Blending Image

For the application of the method describe previously the results are presented on Figure 7, where it can be observed both sides merge, but with recovered details however some effects visual artifacts appear on the resulting image. The details obtained from the Laplacian pyramid can be observed on Figure 8.

4. Conclusions

According to the results and the methods presented, it was proved the importance of the kernel size and the variance in the Gaussian filter behind the pyramids, considering that both are related to the level of blur in the image. That was because, several cut-off frequencies were tried in order to obtain qualitative results.

It was possible to observe and prove the low pass filter effect of a Gaussian filter, and it can be said that the approximation of high pass filter was correct because the desired results were obtained. On the other hand, it was shown that image blending can be done with pyramids, because of the continuous downsampling of the image and then, the reconstruction of the image with the downsampled information which acts as an accumulation of details level after level. As future work, the influence of the levels of the pyramid should be studied in order to obtain better results.

References

[1] OpenCV: Image Filtering.

[2] A. Oliva. The art of hybrid images: Two for the view of one. *Art Perception*, 1(1):65–74, 2013.

[3] A. S. P. Oliva, A. Torralba. Hybrid images, 2006. Massachussetts Institute of Technology SIGGRAPH.

[4] OpenCV. Image pyramids. Image processing. OpenCV. Available:https://docs.opencv.org/2.4/doc/tutorials/imgproc/pyramids/pyramids.html.

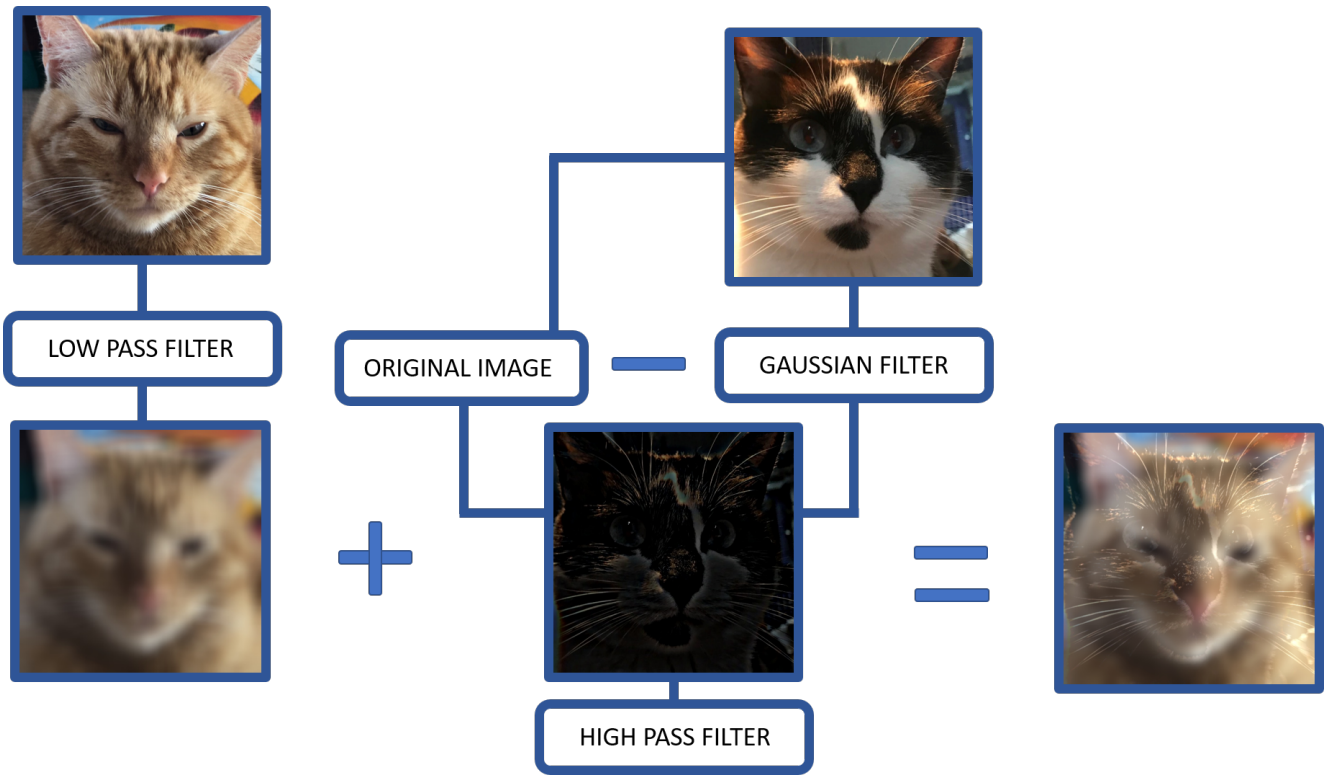

Figure 3. Flow Diagram Hybrid Image

Figure 4. Hybrid image obtained in same scale as save from python algorithm

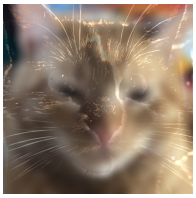

Figure 5. Hybrid image resize to 70% less its resulting size

Figure 6. Pyramid showing different scales of the resulting hybrid image

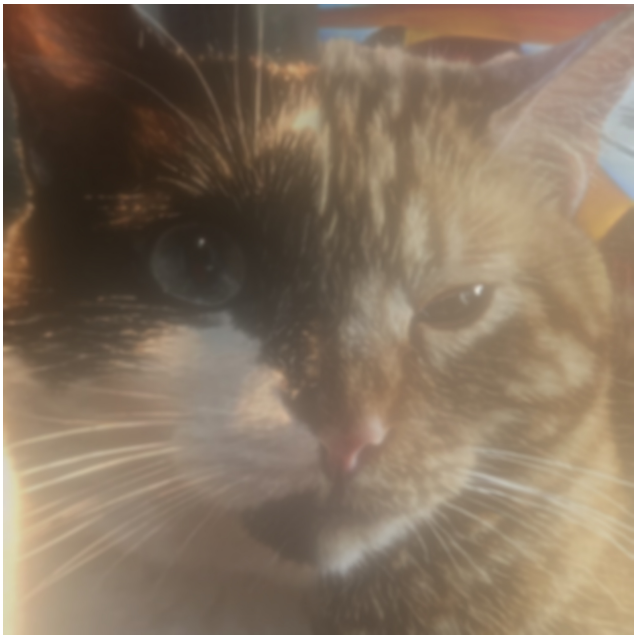

Figure 7.

Figure 8.