Hybrid images and Blending images

Julio Nicolás Reyes Torres
Universidad de los Andes
jn.reyes10@uniandes.edu.co

Juan David Triana
Universidad de los Andes
jd.triana@uniandes.edu.co

Abstract

This report shows the result of applying some kind of images processing to create two different effects, a hybrid image and a composition of blending images. At first, the process to create a hybrid image is shown, the theory about gaussian low pass filter is explained and how overlaid different frequencies gives us a change of perception depending on the visual distance.

Finally, a blending image is made using the Laplacian pyramid theory that implements a series of subsampling to get a smooth appearance of two blended images. The goal of this report is to understand and show an application of those techniques of image processing.

1. Introduction

There are a lot of techniques that produce different visual perceptions in images. For example, Multiscale processing of the human vision is the base to create visual illusions, as the "hybrid images" where two images have different perception depending on the viewing distance. [7] This perception depends specifically on the cut-off frequency, given by the specific standard deviation on the gaussian filter. In general, low frequencies are seen from a far distance in crontrast to high frequencies, which are visible from a close distance.

Another technique to produce different visual perceptions on images is image blending. Image blending allows two concatenated images to lose some characteristics on the borderlines among them. The method to implement this is through a laplacian pyramid (upstream). [4]

2. Hybrid Images

A hybrid image is a technique to produce a single image but with two interpretations in function of the viewing distance, that kind of images are generated by overlaid two different images into different spatial scales. One is mapped in a low spatial scale by filtering with a low-pass filter; the other image, high spatial scale is obtained with a high-pass filter.

Finally, the image is composed by adding these two filtered images, the visual perception change with the distance, at close range the eyes determines high-frequency component image and far away, the interpreted image is the one with low-frequency. [5]

2.1. Methodology

The hybrid image is obtained adding an image filtered with a low-pass filter and the other with a low-pass filter. The equation (1) represents this operation

$$H = I_1 \cdot G_1 + I_2 \cdot (1 - G_2) \tag{1}$$

Where:

- H: Hybrid image
- G_1 : Low-pass filter
- $1 - G_2$: High-pass filter
- I_1, I_2 : Images

The implemented filters were "Gaussians", the value to the window and sigma were determined manually.

2.2. The design of the hybrid image

Following, we are going to show the images used for Student 1 and the filters:

Original Images

1) Student (Nicolás): Figure (1)

Image	Filter
Dominic toretto's car	High pass
DeLorean	Low pass

3. Blending Images

Blending images is also a technique to blend images but using the theory of the Laplacian pyramid. The algorithm implements a process of subsampling with Gaussian Pyramids to get a smooth appearance and after it is expanded to blend the image. [6, 1]

3.1. Methodology

Blended images are obtained by the addition of different feature images from an initial downstream laplacian pyramid. For our algorithm we splitted two images in half, to each one we applied a laplacian pyramid downstream saving each laplacian and gaussian level. In general, it can be interpreted as follows:

$$H = g_1 * F_1 + L_1 \tag{2}$$

Where:

- g_1: Gaussian pyramid level 1
- F_1 Image resize kernel (factor 2)
- L_1 Laplacian Pyramid level 1

Gaussian Pyramid

The elements of a Gaussian Pyramids are smoothed copies of the image at different scales. The Gaussian pyramid is made iterating between these two steps: [3, 2]

- Smoothing: Remove high-frequency components that could cause aliasing.
- Down-sampling: Reduce the image size by half at each level.

Two simple images were taken on a residence in Bogota, Colombia using a Samsung J5 Prime camera. These images were adjusted to a default resolution of 1200X960. These were meant to avoid any odd number division when applying the laplacian pyramid. Additionally, each image was cut in half to be able to merge them into one.

3.2. Creation of blending images

In this section we are going to show the results of the methodology used for blending images and generate a discussion on them. If we take a look at figure ?, we can see the laplacian and gaussian pyramids of the original cat image, using a standard deviation of 60. This was the result of our algorithm using MATLAB functions such as *imgaussfilt()* and *imresize()*. This was very usefull to be able to make mathematical operations between each image on the laplacian and gaussian level. This can be seen on the snipet 8.

We could see that if we increase the standard deviation, details are retained more on the laplacian pyramid. This means that a wider representation space is used on each window when convolution is done for filtering. Furthermore, we can see that an increase on this factor creates a smoother degree of fading between images, as is shown on figure 7. In this manner, we can also compare the original image 10 with the blended one and see that there is a big difference on the smoothing of the borderlines on the middle.

4. Conclusions

The Gaussian Pyramid is very important, because it prevents components that could cause aliasing.
Low frequency images require a longer distance to be able to recognize it, be cause the two different images are into different spatial scale.
Image reconstruction follows an expand-and-sum procedure using the process of Laplacian values.

References

[1] P. J. Burt and E. H. ADELSON. The Laplacian Pyramid as a Compact Image Code BT - Fundamental Papers in Wavelet Theory. *Fundamental Papers in Wavelet Theory*, C(4):532–540, 1983.

[2] U. de Toronto. Topic 6: Hierarchical image representations. Technical report, Universidad de Toronto.

[3] I. Essa. Computational Photography Digital Images : Merging and Blending Images using Image Pyramids. Technical report, School of interactive Computing, 2013.

[4] P. Kari. Stitching and Blending.

[5] A. Oliva, A. Torralba, and P. G. Schyns. Hybrid images. *ACM Transactions on Graphics*, 25(3):527, 2006.

[6] Penn State. Pyramids and Blending. Technical report.

[7] A. Tan. Project 2 - Hybrid Images.

5. Hybrid Images

5.1. Original Images

1) Student 1 (Nicolás): The images were taken in the Universal Orlando Resort, EEUU. Figure (1)

(a) Dominic toretto's car: Dodge SuperCharger R/T

(b) DeLorean dmc-12

Figure 1: First set of images.

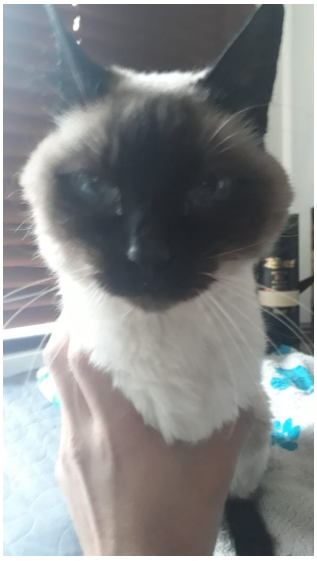

Figure 2: Original Cat image

Figure 3: Original Student image

2) Student (Juan David): Images were taken inside home residence in Bogota, Colombia.

5.2. Hybrid Image

(a) Image with Low pass filter

(b) Image with High pass filter

Figure 4: Filtering the images.

Finally, the hybrid image is obtained adding the two images filtered:

Figure 5: Finally, Hybrid image.

6. Blending Images

1) Student 1 (Nicolás): Two cars blended, Mercedez AMG GT y Range Rover. The photos were taken in the "Salón del automóvil" (2018).

(a) The two joined images

(b) The two images blended

Figure 6: Blending images.

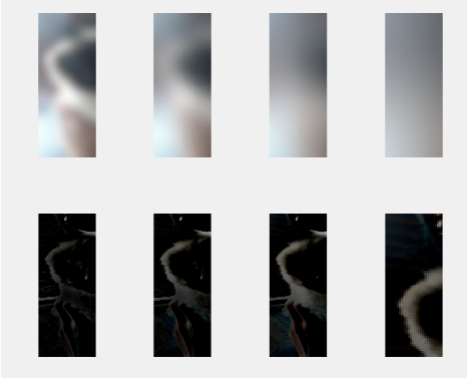

Figure 7: Laplacian pyramid using cat image

```
for i =1:g
    [m,n,l] = size(pepe_h);
    pepe_ha = pepe_h;
    pepe_h = imresize(pepe_h,[m/2,n/2]);
    pepe_g = imgaussfilt(pepe_h,60);
    [s,p,t] = size(hombre_h);
    hombre_ha = hombre_h;
    hombre_h = imresize(hombre_h,[s/2,p/2]);
    hombre_g = imgaussfilt(hombre_h,60);
```

Figure 8: Snippet of the code used for image blending

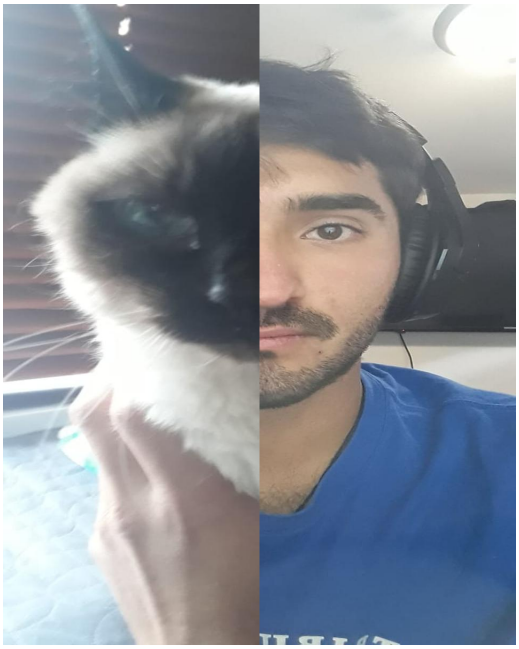

Figure 10: Original blend image.

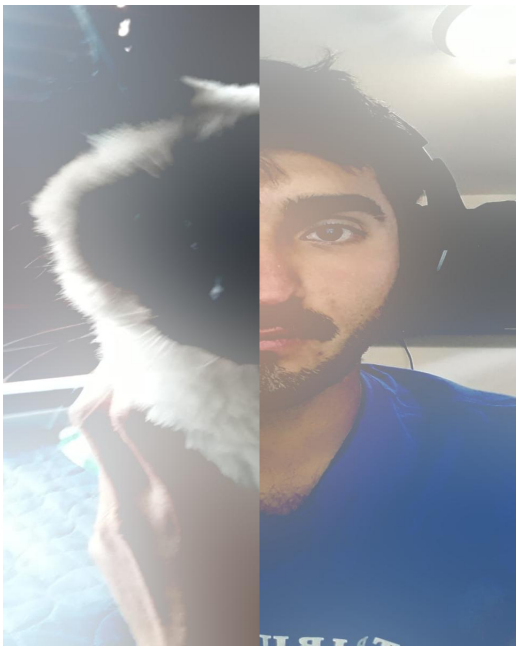

Figure 9: Blended image