Hybrid Images: Laboratory 04

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***Abstract*—In this report the process to generate a hybrid image by adding two filtered images will be described. In addition, the procedure to generate blended images using Gaussian pyramids will be detailed. The results obtained from the hybrid images are satisfactory being possible to identify one image from the closest distance and the other from far away. Finally, the results obtained for the blended images via the usage of Gaussian pyramids, are the desired ones due to the fact of the proper blending in the middle line, where both images join.**

I. Introduction

Hybrid images are interesting because they create visual illusions in human vision where two different interpretations of a picture may be perceived by changing the distance of view. The hybrid image concept started out in 2006, when Aude Oliva, Antonio Torralba, and Philippe. G. Schyns first presented this concept to explain the Dali's painting " Gala Contemplating the Mediterranean Sea" and the faded smiles of da Vinci's "Mona Lisa". These images are created by superimposing two images. One of them must be filtered by a low-pass filter (G1) and the other one with a high-pass filter (I-G2). The final hybrid image (H) results by adding both (H = I1G1+I2(I2-G2)) [1].

Laplacian pyramids are representation of images in multiple spatial scales. The goal when using Laplacian pyramids is to define a representation in which image information at different scales is explicitly available [2]. These kinds of pyramids have important applications in image processing such as scale invariant template matching, progressive image transmission, feature search and image blending.

In this work we first generate a hybrid image using low-pass and high-pass Gaussian mask filter with two President images. It was necessary to process the images first in a photo shop program to align both and get better results. In the second part, Laplacian pyramids were used to generate blending images. Face images and Gaussian filters were used in this part too and like the first part, the alignment in the photo shop program was necessary.

II. Materials and Methods

A. Image description

Images for the creation of the hybrid image were recovered from Google Images since we wanted to use President Duque and President Uribe for the formation of the new image. For the creation of the blended image we use images from https://thispersondoesnotexist.com/, a website which creates by artificial intelligence people's faces that do not exist. Images of this website were used because they are largely aligned and have similar sizes. Likewise, they have a default size of 1024 * 1024 which is perfect to build up the pyramid.

B. Image modification

Faces of each image were aligned using the GIMP program. The image of President Duque was cut by this program and re-scaled to the size of the original image, so the size of the modified images is 800x600. The blended images were also aligned and they were proved several times that each half of one of them fit as well as possible in the other. To align these images, they were cut and then re-scaled to their original size of 1024x1024.

C. Important features of the developed code

1) Hybrid Images: As a first aspect, the images are uploaded to Dropbox so they are automatically downloaded to the current folder. The images are downloaded as a .zip and later decompressed in the code. For the filtering part, a low pass filter was imported for the Uribe image, using the following line, where A is Uribe's image:

lowPassedA = gaussian (A, sigma = 10, multichannel = True)

Duque was filtered with a high pass filter, using the following lines of code, with B being Duque's image:

lowPassedB = gaussian (B, sigma = 70, multichannel = True)
BLow = ndimage.imread ("low-passed-B.png", flatten = False)
BHighPassed = cv2.subtract (B, BLow)

The Gaussian filter was imported from the skimage.filters library [3] and subtract command was used from the cv2 library to avoid possible negative values. The sigma value of each filter was different. Finally, with the cv2 add command, the filtered images of Duque and Uribe were joined to obtain the hybrid image. The image is saved in the user's current folder.

2) Blended images: Four levels of pyramid were used for each of the images. To filter and at the same time reduce the size of the image by half, the misc.imresize and the Gaussian filter commands were used both from the skimage library. All images were 1024x1024 and images in level 4 had a size of 64x64.

All the images were filtered with the same filter command and with the same sigma value of 0.1. The size of the window was the standard given by the skimage command. Bicubic interpolation was applied in all filters. Note that the images were joined half and half in the fourth level of the pyramid and then followed by the step of re-scaling and adding the respective Laplacian.

To re-scale the image and filter it at the same time, the pyrUp command [4] was used and each level was added with its respective Laplacian. It should be noted that each Laplacian was divided in half to be added to the combined image. The combined image was returned to level 1 of the pyramid and returned to the original size of each image (1024x1024). Blended image is saved in the user's current folder.

Figure 3. Hybrid image obtained.

III. Results

The original images and the hybrid image obtained are shown as follows:

Figure 1. Original Image A.

Figure 2. Original Image B.

Figure 4. Hybrid image obtained.

Figure 5. Hybrid image obtained.

Figure 6. Hybrid image obtained.

The blended images obtained are shown as follows:

Figure 7. Image obtained without pyramid blending.

Figure 8. Image obtained with pyramid blending.

Figure 9. Image obtained without pyramid blending.

Figure 10. Image obtained with pyramid blending.

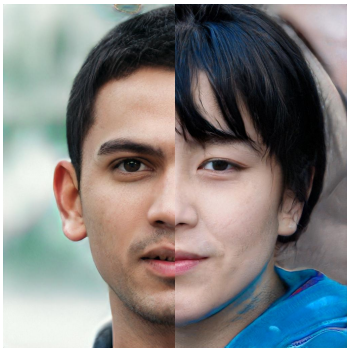

Figure 11. Image obtained without pyramid blending.

Figure 12. Image obtained with pyramid blending.

The different scales of the pyramid used are shown as follows:

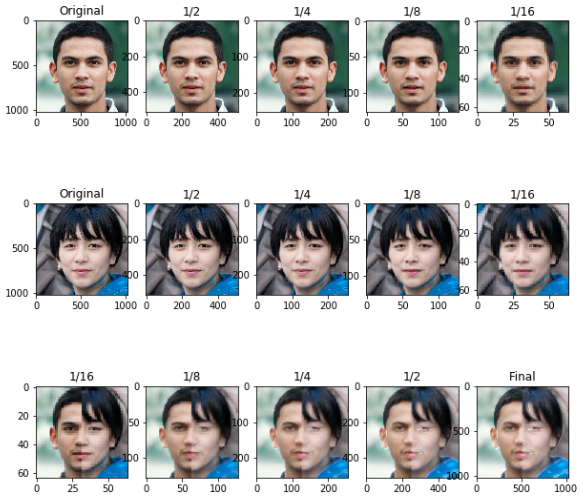

Figure 13. Original images and their pyramid scales.

IV. Conclusions

The results obtained in the task of creating a hybrid image were satisfactory but with certain limitations. One of them was the need to pre-processing images in a photoshop program to align them and obtain the desired results. It should be noted that for this to work (at least on faces which were our test images) the faces must have similarity in shape to create the desired visual effect. The same limitations are presented in the task of creating a blending image, however, in this part we obtained better results because the website which we obtained the images presented the same size and alignment of faces.

References

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[2] D. Martin, "Gaussian Laplacian pyramid construction ." University of Toronto, Toronto, 2010.
[3] Scikit, command searched in http://scikit-image.org/docs/dev/api/skimage.filters.html
[4] OpenCV, command searched in $https$: $//docs.opencv.org/3.1.0/dc/dff/tutorial_pyy_pyramids.html$